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An introduction to international money and foreign exchange markets

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AN INTRODUCTION TO INTERNATIONAL MONEY AND FOREIGN EXCHANGE MARKETS

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Abstract

This five-chapter introduction into international money and foreign exchange markets covers all the basics, theoretical, institutional, as well as empirical. After a brief review of the money market, we discuss the size and structure of the foreign exchange markets. This information is then used in discussing purchasing power parity and interest rate parity. We conclude with an overview of the main international money organizations and the institutional framework of the past 150 years.

JEL codes: E, F, G

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Contents

Preface

This study into the fundamentals of the international money and foreign exchange markets was undertaken while I was visiting professor at the University of Adelaide, Australia, July – November, 2004. I am grateful to the University of Adelaide for its hospitality which made this visit possible and to the staff of the School of Economics for encouragement and friendship. This research is part of a preparation for a monograph with the working title *International Economics: Theory, Application, and Policy*, to be published by Oxford University Press in due time as an update and extension of my earlier work: *International Trade and the World Economy* (van Marrewijk, 2002). Comments and suggestions for improvement sent to the email address on the front page will be greatly appreciated. I would like to thank Stephan Schueller and Daniël Ottens for some of the data material and Daniël Ottens for useful comments and suggestions.

CvM, October 2004

Chapter 1 Money market

Objectives / key terms

Central Bank	commercial banks
banking system	means of payment
store of value	unit of account
monetary base	M_1, M_2, and M_3
quantity theory of money	velocity of money
money supply process	money multiplier

We start the monetary part of this book with a basic review of the money market, describing the functions of money, different types of money, the demand for money, the money supply process, and monetary equilibrium.

1.1 Introduction

The money market plays a crucial role in the economy, through its unique position relative to all other markets. A smoothly operating money market allows an economy to function properly by conveying (changes in) relative prices of different goods and services (and thereby relative scarcity) as clearly as possible. This chapter gives a brief review of the main aspects of the money market, by discussing the functions of money, listing different types of money, describing money demand and supply, and analyzing the monetary equilibrium. Before we do that, however, it is good to review the five main players on the money market. These are:

- *The central bank*; in modern countries the central bank is guaranteed a monopoly over the supply of banknotes and coins and is responsible for a smoothly operating monetary system. Examples are the Bank of Japan (BoJ), the Bank of England (BoE), and the Federal Reserve system (FED) in the United States and the European Central Bank (ECB) for the European countries that participate in the Economic and Monetary Union (EMU).
- *Commercial banks*; through their role as an intermediary between borrowers and lenders, commercial banks are at the center of the (international) money and capital

markets. Their liabilities consist mainly of deposits and their assets of loans (to firms, households and the government), deposits at other banks, and bonds. The *banking system* consists of the central bank together with the commercial banks. Table 1.1 lists the top ten commercial banks in the USA as of 31 March 2004, ranked by consolidated assets. It shows, for example, that the largest bank has assets worth almost $ 700 billion, that some banks have large assets abroad, that the top ten banks own about 50 percent of the total consolidated assets for all banks (of which there are 1,376), and that only one bank in the top ten is owned by foreigners.

Table 1.1 Top 10 commercial banks in the USA, as of 31 March 2004

rank	bank name and location	consol assets (mil $)	domestic assets (mil $)	dom as % cons	cuml as % cons	% fgn own
1	bank of amer na charlotte, nc	690,573	647,499	94	10	0
2	jpmorgan chase bk new york, ny	648,692	382,594	59	19	0
3	citibank na new york, ny	606,191	274,283	45	28	0
4	wachovia bk na charlotte, nc	364,474	343,056	94	33	0
5	wells fargo bk na sioux falls, sd	347,560	347,045	100	38	0
6	bank one na chicago, il	256,701	236,246	92	42	0
7	fleet na bk providence, ri	195,323	178,566	91	45	0
8	u s bk na cincinnati, oh	191,606	191,606	100	47	0
9	suntrust bk atlanta, ga	124,298	124,298	100	49	0
10	hsbc bk usa buffalo, ny	99,867	89,724	90	50	100

Source: www.federalreserve.gov , ranked by consolidated assets; consol assets = consolidated assets ; dom as % cons = domestic assets as a percentage of consolidated assets ; cuml as % cons = cumulative consolidated assets as a percentage of the sum of consolidated assets for all banks; % fgn own = percentage of foreign ownership; total number of banks = 1,376; total cons assets = 6,982,131 million.

- *Government sector*; although the central bank is a government organization, it is useful to explicitly distinguish between the central bank and other government organizations, either at the national, regional, or municipal level, since they play different roles in the money market and have different responsibilities regarding the macroeconomic performance of an economy.

- *Private non-bank public*; the majority of the activities of the commercial banks relates to the private non-bank public, that is consumers and firms who hold deposits at the banks or borrow money from the banks.
- *Foreign sector*; international organizations and foreign consumers, firms, and governments are grouped under the heading foreign sector. Changes in a country's net position relative to the foreign sector often play a crucial role for understanding international money and capital markets.

1.2 The functions of money

The easily-posed question: "what is money?" has turned out notoriously difficult to answer, particularly given the variety of financial instruments used on today's financial markets. Although John Hicks (1967) focuses on the functions of money for a definition:

> "Money is what money does. Money is defined by its functions."

It will be clear from the discussion of these functions below that it is hard to use that as a basis for determining what should and what should not be classified as money. We can safely conclude that at this moment there does not exist a commonly accepted answer to the above posed question. In a sense, money is like a chair: fairly easy to recognize, but hard to define. Economists distinghuish between three primary functions of money:

- *Means of payment*; without 'money' as a generally accepted means of payment exchange would be only possible if there is a 'double coincidence of wants': I can buy your pig only if you will take my five sacks of rice in return. Alternatively, we could look for indirect means of exchange: I sell my five sacks of rice to John, who gives you two kegs of beer, while you give me your pig. Obviously, the transaction costs for this type of barter exchange are very high, seriously limiting the efficiency of economic interaction. The most important function of money is therefore undoubtedly its use as a means of payment. Historically, precious metals, such as gold and silver coins, have been used for this purpose. More prozaic means, such as shells on certain islands and cigarettes in World War II prisoner of war camps, have also been used. Nowadays, it is either paper bills and coins in your wallet or digital numbers on your bank account.

- *Store of value*; if money is accepted as a means of payment it automatically also functions as a store of value, at least during the time period in which the person receiving the money holds on to it before paying someone else. This time period tends to be shorter if the inflation rate is high, since the usefulness of money as a store of value diminishes if the value of money rapidly falls. Many other assets also function as a store of value.
- *Unit of account*; money also provides the more abstract function of a unit of account as the legal currency for a certain area, such as dollars in the United States, yen in Japan, and euros in the Economic and Monetary Union (EMU) in Europe. It functions as a numéraire to compare prices of different goods, which greatly reduces information and transaction costs. Without a unit of account it is hard to say if a stapler which costs five handkerchiefs in one shop is more expensive than in another shop where it costs four batteries, particularly if we realize the possible number of comparisons. If there are n goods, there are $(n/2)(n-1)$ relative prices; so 1,000 goods implies 499,500 relative prices and one million goods implies 500 billion relative prices. Expressing all prices in the same unit of account makes comparisons much easier. The unit of account is also used for legal documents, for borrowing and lending, as a standard for measuring wealth and a means for aggregation, etc.

1.3 Different types of money

Various 'monetary assets' at least to some extent perform the functions of money listed in section 1.2. Not surprisingly, therefore, there are several solutions to the *classification problem* – defining the borderline between money and other financial assets. As a result of financial innovations, which have made it increasingly easy to use bank deposits as a means of payment, the policy emphasis has shifted over time towards broader monetary aggregates. From narrow to broad, the four most common definitions of money are (see also section 1.5 for the symbols used below):

- *Monetary base* (B); consists of currency in circulation (C) and reserves (R) that commercial banks hold at the central bank (which can be converted to currency at negligible transaction costs): $B = C + R$.

- *Money stock M_1*; consists of currency in circulation (*C*) and private non-banks's overnight deposits (*OD*; which can be converted to currency at negligible transaction costs, for example using cash dispensers, also called sight deposits): $M_1 = C + OD$.
- *Broader money stock M_2*; consists of M_1 + time deposits (*TD*, that is deposits with agreed maturity up to two years) + savings deposits (*SD*, that is deposits redeemable at notice up to three months). $M_2 = M_1 + TD + SD$.
- *Broader money stock M_3*; consists of M_2 + other short term liabilities (*OSL*) of the banking system (repurchase agreements, money market fund shares/units and money market paper, and debt securities with maturity up to two years): $M_3 = M_2 + OSL$.

Unfortunately, these definitions and measurements of these monetary aggregates are not entirely the same in all countries. Table 1.2 summarizes some of these differences for Japan, Europe, USA, and UK.

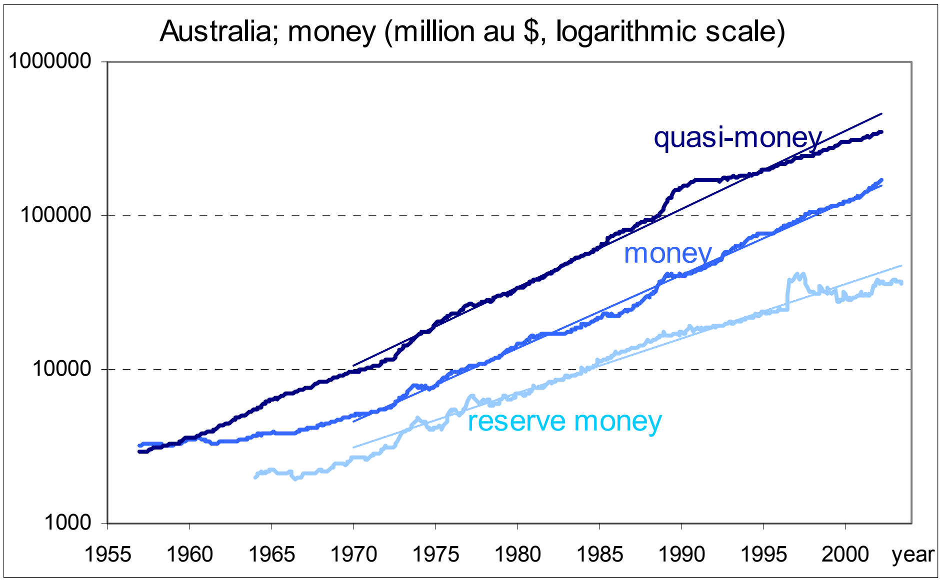
Table 1.2 Definitions of money in Japan, UK, USA, and Euro area

Country	M_1	M_2	M_3
Euro area (ECB) and UK	Currency in circulation + overnight deposits	M_1 + deposits with agreed maturity up to 2 years + deposits redeemable at notice up to 3 months	M_2 + repurchase agreements + money market fund shares/units and money market paper +debt securities up to 2 years
Japan	Currency in circulation + deposit money	M_1 + quasi-money	Not reported, but: M_2 + certificates of deposits
USA	Currency + checkable deposits	M_1 + household holdings of savings deposits, time deposits, and retail money market funds	M_2 + institutional money funds + managed liabilities of depositories, namely large time deposits, repurchase agreements, and eurodollars

Source: Bofinger (2001, p. 16)

Figure 1.1 depicts the volume of these different types of money stock in Australia since the 1950s. As the figure uses a logarithmic scale, the slopes of the various lines give the growth rates of the money stocks. As is evident from the trendlines summarizing the behavior over longer time periods in Figure 1.1, the broader money stocks increased faster in Australia. Although this is generally the case for most economies, it is not a universal phenomenon, see Figure 1.2a.

Figure 1.1 Australia; different types of money



Data source: IFS; the thin lines are trendlines starting at 1970; trend growth rates since 1970 are 8.14%, 10.96%, and 11.66% per year for reserve money, money (M_1), and quasi-money (M_2), respectively.

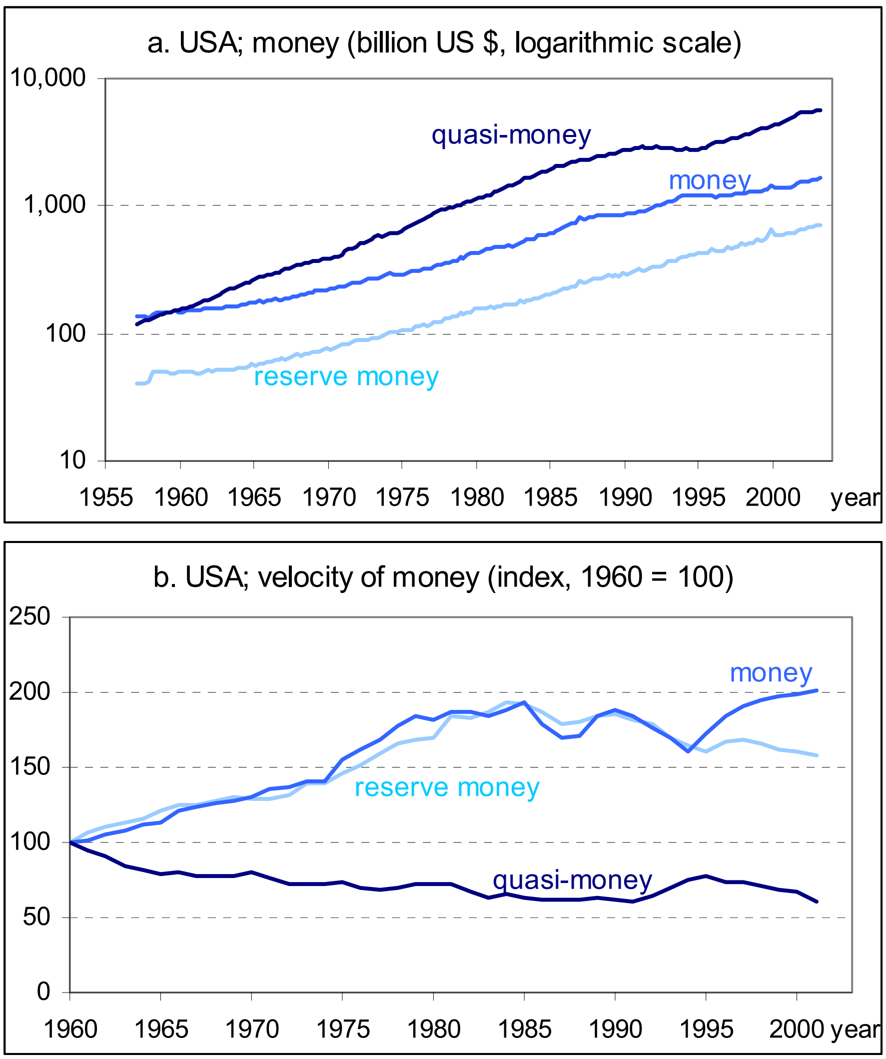
1.4 The demand for money

The demand for money is obviously related to the functions of money described in section 1.2. Since its primary use is as a medium of exchange, the first theory of the demand for money, the quantity theory of money based on Irving Fisher (1911), focused on this function. On the straightforward assumptions that the number of transactions increase as the size of the economy (as measured by real income Y) increases and that the need for money (M) per transaction rises if the price level (P) increases, the standard specification of the *quantity theory of money* is:

(1.1) $MV = PY$, where V is the income velocity of money.

A few remarks on this specification are in order. First, as stated equation (1.1) does not give the demand for money, but merely *defines* the income velocity of money. It only becomes an indication for the (transactions) demand for money once we make auxiliary assumptions concerning the behavior of the income velocity of money. Initially, a popular, but questionable, assumption used in this respect was a constant velocity of money, say $\overline{V}$, in which case equation (1.1) implies: $M^d = PY/\overline{V}$. Since that specification ignores the other functions of money and is empirically refuted (see, for example, Figure 1.2b), it is hardly used anymore. Second, since there are different types of money identified in practice (see section 1.3), we also have different types of income velocities of money associated with these different types of money as specified by equation (1.1). This is illustrated for the USA in Figure 1.2.

Figure 1.2 Money stocks and velocity of money in the USA



Source: own calculations based on IFS and Worldbank Development Indicators 2003.

Figure 1.2a illustrates that a broader money stock does not necessarily grow faster than a more narrowly defined money stock. Moreover, it is evident from Figure 1.2b that the income velocity of money is not constant and may move in opposite directions for different types of money. Needless to say, this makes the central bank's policy choices aimed at maintaining price stability more challenging than if the signals it received were all pointing in the same direction.

Individuals holding money face a simple trade-off: liquidity versus return. Basic forms of money holdings earn no interest (i), but can be used immediately, if necessary, as a means of payment. Parts of broader money stocks earn a (low) interest rate at the expense of a somewhat lower liquidity. Both compete with still less liquid financial assets earning a higher rate of return. Most theories of money demand focus on this trade-off between liquidity and return in addition to the use of money as a medium of exchange. Keynes's (1936) theory of liquidity preference, for example, identifies a transactions motive, a precautionary motive, and a speculative motive for holding money. Money demand is therefore not only influenced by the level of production in an economy, but also by the interest rate, representing the opportunity cost of holding money. Similarly, in the Baumol (1952) – Tobin (1956, 1958) inventory model, individuals determine the number of trips to the bank as a function of the income level and the interest rate. A basic theoretic money demand function is therefore given by (see also Boxes 1.1 and 1.3):

(1.2) $M^d / P = M^d(\underset{-}{i}, \underset{+}{Y})$

In view of the specification in equation (1.1), this can be interpreted as an attempt to explain how the interest rate influences the income velocity of money.[1] Most empirical estimates of money demand functions use a log-linear specification. If we let i denote the interest rate the real money demand is either specified as:

(1.3a) $\ln(M_t / P_t) = \beta_0 + \beta_1 \ln(Y_t) + \beta_2 \ln(i_t) + \varepsilon_t$, or as:

(1.3b) $\ln(M_t / P_t) = \beta_0 + \beta_1 \ln(Y_t) + \beta_3 \, i_t + \varepsilon_t$,

[1] Note that other factors, such as financial innovations, also influence the demand for money.

where ε_t is an error term. The parameters β_1 and β_2 are the income and interest rate elasticities of money demand, respectively, as they indicate by what percentage the real demand for money changes per percentage change in the income level or interest rate. The specification in (1.3b), where the interest rate term is non-logarithmic, is more popular in empirical work. In that case the parameter β_3 is called the *semi-interest elasticity* of money demand, as it shows the percentage by which the real demand for money changes if the interest rate changes by one percentage point.

Box 1.1 Wealth and the demand for money

Milton Friedman (1956) emphasizes that the demand for money should be treated like the demand for goods and services. In this respect an individual's wealth plays an important role. Friedmand identifies five components of wealth: money, bonds, shares, real assets, and human capital. Money is therefore just one of the components of wealth and, as in the usual theory of consumer choice, the demand for money depends on; (i) the budget constraint (total wealth to be held in various forms), (ii) the price and return of wealth and alternatives, and (iii) an individual's preferences. In general, therefore, the demand for money depends on the return to all individual components of wealth, the income level, the wealth level, and preferences. Obviously, it is very difficult to quantify all possible types of real assets and human capital and their respective returns, which makes the theory hard to apply empirically. However, it is clear that the wealth component plays a role in the determinants of the demand for money. Coenen and Vega (1999), for example, estimate the following demand for money (M_3) in the euro area:

(1.4) $$\ln(m_t) = 1.140\ln(Y_t) - .820(i_{bond,t} - i_{money,t}) - 1.462\pi_t + \varepsilon_t \ ,$$

where π_t is the inflation rate. The fact that the income elasticity of money demand is above unity can be contributed to the wealth effect (since in the period under investigation nominal wealth rose more quickly than nominal income). The estimated semi-interest elasticity for the broad money stock M_3 in equation (1.4) is negative, as expected, and based on the difference between the long-run and the short-run interest rate (since some components of M_3 do earn interest). Finally, the inflation rate in the economy has a negative influence on the demand for money as inflation erodes the value of the money stock, see also Box 1.3.

1.5 The money supply process

To understand the money supply process we will study the balance sheets of the central bank and the banking system. It is important to realize that this process is a two-step procedure: the central bank directly controls the monetary base and indirectly influences broader money stocks M_1, M_2, and M_3 through its control of the monetary base and other instruments affecting the behavior of commercial banks, such as the interest rate for reserves and the minimum reserve ratio. Table 1.3 summarizes the financial statement of the Eurosystem (ECB plus central banks participating in the euro).

Table 1.3 Consolidated weekly financial statement of the Eurosystem, 20 August 2004

assets	balance	liabilities	balance
gold and gold receivables	127,382	banknotes in circulation	462,185
claims on non-euro area residents denominated in foreign currency	173,010	liabilities to euro area credit institutions related to monetary policy operations denominated in euro	140,356
claims on euro area residents denominated in foreign currency	17,104	other liabilities to euro area credit institutions denominated in euro	125
claims on non-euro area residents denominated in euro	7,261	debt certificates issued	1,054
lending to euro area credit institutions related to monetary policy operations denominated in euro	320,998	liabilities to other euro area residents denominated in euro	56,132
other claims on euro area credit institutions denominated in euro	1,415	liabilities to non-euro area residents denominated in euro	9,016
securities of euro area residents denominated in euro	67,862	liabilities to euro area residents denominated in foreign currency	244
general government debt denominated in euro	42,086	liabilities to non-euro area residents denominated in foreign currency	11,869
other assets	114,858	counterpart of special drawing rights allocated by the IMF	5,896
		other liabilities	55,123

		revaluation accounts	70,205
		capital and reserves	59,771
total assets	871,976	total liabilities	871,976

Source: www.ecb.int ; data are in euro millions

Like all other balance sheets, Table 1.3 is organized according to the principles of double-entry bookkeeping. The sum of all assets is therefore necessarily equal to the sum of all liabilities. The assets are central bank holdings of claims to future payments, either by its citizens, commercial banks, the government sector, or the foreign sector. The majority of the domestic assets held by the central bank are loans to domestic commercial banks and domestic government bonds. The foreign assets constitute the central bank's official international reserves. Its level changes if the central bank intervenes in the foreign exchange market by buying or selling foreign exchange (or alternatively by changes in exchange rates which influence the balance sheet valuation of international reserves). Table 1.3 shows that on 20 August 2004 the total value of all assets of the Eurosystem was 871,976 million euro. The liabilities side of the central bank balance sheet lists currency in circulation and deposits of commercial banks. The latter are largely deposits required by law as partial backing for the liabilities of the commercial banks. Individuals and nonbank firms can, in general, not deposit money at the central bank. Figure 1.3 simplifies the information given in Table 1.3 to highlight the position of the central bank relative to other players on the money market.

Figure 1.3 Simplified financial balance sheet of the central bank

Financial balance sheet of the central bank

Assets	Balance	Liabilities	Balance
Net position vis-a-via the foreign sector (including gold holdings)	NPFor	Currency in circulation	C
		Deposits of the domestic banking sector	R
Net position vis-a-vis the domestic government sector	NPGov	Balance of other assets and liabilities	BalCB
Credits to the domestic banking sector	CrBank		
Total net assets		Total net liabilities	

Using Figure 1.3, the properties of the balance sheet, and the definition of the monetary base given in section 1.3, it follows that:

(1.5) $B = C + R = NPFor + NPGov + CrBank - BalCB$

Ignoring changes in the central bank's balance of other assets and liabilities (BalCB) for simplicity, equation (1.5) shows that changes in the monetary base come about through changes in the central bank's net position relative to the foreign sector, its net position relative to the government sector, or credit extended to the commercial banks. Let's discuss examples of each of these possibilities in turn.

1. If the central bank intervenes in the foreign exchange market by purchasing foreign currency from a commercial bank, the central bank's net position relative to the foreign sector (and its official reserves) increase. In general, the purchase is paid for by crediting the commercial bank's account at the central bank by the same amount, such that the deposits of the banking sector (R), and therefore the monetary base, increase by the same amount. However, the central bank can take countervailing measures, such as 2 or 3 below, to prevent changes in the monetary base occurring as a result of foreign exchange intervention. This is called *sterilization* of interventions[2].

[2] The central bank usually intervenes to attain some sort of exchange rate target and might sterilizes these interventions to prevent changes in the domestic money stock.

2. If the central bank grants a loan to the state, its net position relative to the government, and hence the monetary base, changes as soon as the state starts to spend the funds by paying firms or individuals (credited to an account at a commercial bank). Similarly, if the central bank purchases or sells government bonds (open-market policy), the monetary base increases or decreases, respectively. In many European countries, the direct purchase of government bonds (from the government) is forbidden, so that the central bank can only buy government bonds in the secondary market. This is not frequently done in Europe, but it is in Japan (as a means to change the monetary base).
3. If the central bank grants a loan to a commercial bank, for example under a credit facility, the monetary base increases by the same amount.

To discuss changes in the money stocks M_1, M_2, and M_3, we have to focus on the second step of the money supply process, in which the monetary base can be seen as an input. It is most useful to look at the consolidated balance sheet of the banking system as a whole, that is aggregate the balance sheet of the central bank and all commercial banks into a single balance sheet. This means that all claims between commercial banks and between the central bank and commercial banks are netted out. Figure 1.4 presents a simplified version of this consolidated balance sheet similar to Figure 1.3 for the central bank. The asset side consists of three entries: the net position of the banking system relative to foreigners (NEA), credits of the banking system to the domestic government sector (CrGov), and credits to the domestic private non-bank sector (CrDom). The liabilities side of the consolidated balance sheet distinguishes between the various assets included in the different types of money discussed in section 1.3, see equation (1.6).

Figure 1.4 Simplified consolidated financial balance sheet of the banking system

Consolidated financial balance sheet of the banking system

Assets	Balance	Liabilities	Balance
Net external assets (including gold holdings)	NEA	Currency in circulation	C
		Overnight deposits	OD
Credits to the domestic government sector	CrGov	Time deposits (with agreed maturity up to 2 years)	TD
Credits to the domestic private non-bank sector	CrDom	Savings deposits (redeemable at notice up to 3 months)	SD
		Other short-term liabilities of the banking system	OSL
		Balance of other assets and liabilities	BalBS
Total net assets		Total net liabilities	

(1.6a) $$M_1 = C + OD$$

(1.6b) $$M_2 = M_1 + TD + SD$$

(1.6c) $$M_3 = M_2 + OSL = NEA + CrGov + CrDom - BalBS$$

Ignoring changes in the banking system's balance of other assets and liabilities (BalBS) for simplicity, equation (1.6c) shows that changes in the money stock M_3 come about through changes in the banking system's net external assets, credit extended to the government sector, or credit extended to the private non-bank commercial banks. The mechanics of changing the broad money stock M_3 is therefore quite similar to the mechanics of changing the monetary base. In general, money is created when a bank purchases claims from a non-bank. The broader money stocks M_2 and M_3 include (interest bearing) credits (time deposits, savings deposits, and other short term liabilities of the banking system). The general money supply model to be discussed below is also valid for these broader money stocks. However, for ease of exposition we will henceforth focus our discussion on the money stock M_1.

Agreement: in the remainder of the book, the term "money" will refer to the money stock M_1, unless explicitly stated otherwise.[3]

Box 1.2 Mechanistic money multiplier

The simplest way to link the two steps of the money supply process, from the monetary base to the money stock, is by assuming mechanistic behavior on part of the commercial banks, as summarized in the following two ratios:

- $c \equiv C/OD$, the cash holding ratio
- $r \equiv R/OD$, the reserve ratio.

The first indicates that there will be some constant ratio of cash to overnight deposits and the second that there will be a constant ratio of deposits of the banking sector at the central bank to overnight deposits, dictated by the central bank's minimum reserve requirtements. The money multiplier (*mult*) is defined as the ratio between the money stock and the monetary base. From the above it follows that:

$$mult \equiv \frac{M}{B} = \frac{OD+C}{C+R} = \frac{(OD/OD)+(C/OD)}{(C/OD)+(R/OD)} = \frac{1+c}{c+r} \tag{1.7}$$

Although this multiplier process can be embellished using a quasi-dynamic story, the end result is that there is a one-to-one correspondence between the monetary base and the money stock. If the central bank controls the monetary base, it therefore also controls the money stock. The discussion in the text explains how the behavior of commercial banks, which depends on (differences in) interest rates, complicates this process, and thus makes the money multiplier a function of, for example, interest rates.

Box 1.2 explains how the supply of monetary base is equivalent to the supply of money if commercial banks behave like automatons. Like any other firm, however, commercial banks strive for profit maximization, which depends on the demand for credit, their market position, and their cost structure. Although we will not go into the details of this process it is clear that two interest rates pay a crucial role for the commercial bank's profitability, see Klein (1971) and Bofinger (2002, ch. 3):

[3] This implies, retro-actively, that we discussed the demand for money stock M_1 in section 19.4.

- i, the interest rate on credit extended by the bank
- i_{res}, the interest rate for reserves held by the bank at the central bank.

If the interest rate i on credit extended by the bank, henceforth referred to as "the" interest rate, increases it becomes more attractive for the bank to extend credit. It is identical to the effect of a price increase for the supply of goods or services for any regular firm. The interest rate for reserves held by the bank at the central bank i_{res}, known as the refinancing rate, is paid on the minimum reserve ratio which is determined by the central bank. A single bank takes its level of deposits as given, depending on stochastic flows. The supply of reserves is perfectly elastic at the refinancing rate i_{res}, set by the central bank, which represents the costs of refinancing an unexpected drain of deposits (at the central bank or other banks). Acknowledging that the money supply process also depends on general economic conditions, as measured by real income Y, we get:

(1.8) $$M^s = M^s(\underset{+}{i}, \underset{-}{i_{res}}, \underset{+}{Y})$$

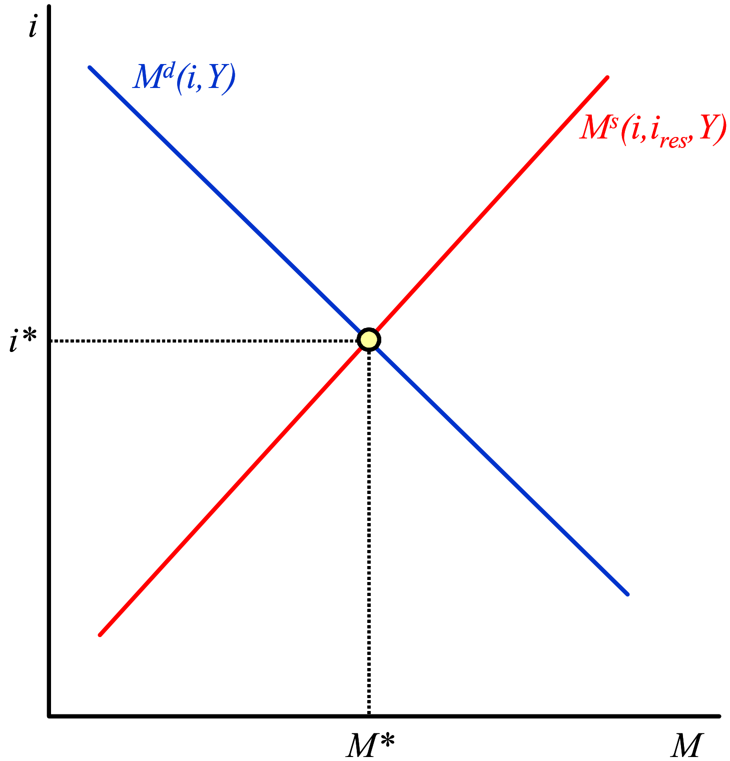
Having thus derived a simple money demand function in section 1.4 and an elementary money supply function in this section, the next section discusses how these two interact to determine the monetary equilibrium.

1.6 Monetary equilibrium

The demand for money, equation (1.2) must, in macroeconomic equilibrium, be equal to the supply of money, equation (1.8). Monetary equilibrium is therefore given in equation (1.9), where the demand for money is equal to the supply of money. Together these forces determine the interest rate and the money stock in an economy as a function of, inter alia, the refinancing interest rate and the income level. This is illustrated in Figure 1.5, where $i*$ and $M*$ are the equilibrium interest rate and money stock.

(1.9) $$M^d(\underset{-}{i}, \underset{+}{Y}) = M^s(\underset{+}{i}, \underset{-}{i_{res}}, \underset{+}{Y})$$

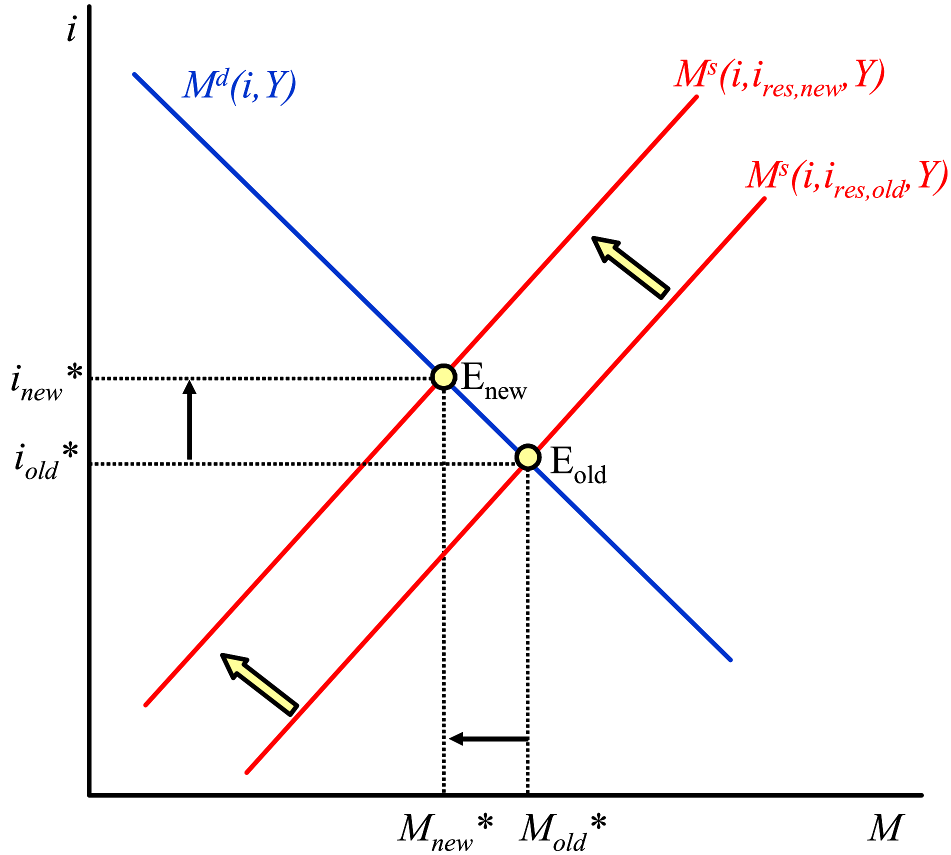
Figure 1.5 Monetary equilibrium



So how does the central bank influence the monetary equilibrium? This is illustrated in Figure 1.6 if the central bank uses interest (refinance) rate targeting. Suppose the initial refinance rate is $i_{res,old}$. The monetary equilibrium is then at point E_{old} with interest rate i_{old}^* and money stock M_{old}^*. If the central bank thinks this level of the money stock is too high and the economy might become overheated, it can increase the refinance rate, to $i_{res,new}$ say.[4] This increases the costs of refinancing for commercial banks, who therefore shift their money supply schedule to the left, as indicated in Figure 1.6. A new monetary equilibrium results from the interaction of the money demand schedule and the new money supply schedule at point E_{new}, resulting in a lower equilibrium money stock M_{new}^* and a higher equilibrium interest rate i_{new}^*. A tighter monetary policy by the central bank, in this case a higher refinance rate, therefore causes a higher interest rate in monetary equilibrium and a lower money stock through the interaction of market behavior by banks, firms, and consumers.

[4] Note that we use the terms "old" and "new" here to avoid confusion which might arise from the standard use of "0" and "1" in view of their association with different types of money stocks, see section 19.3.

Figure 1.6 An increase in the reserve interest rate and monetary equilibrium



As an alternative to interest rate targeting the central bank might be using monetary base targeting, that is determine the level of the monetary base rather than the level of the refinance rate. Since commercial banks, through their profit maximizing behavior, ensure a negative relationship exists between the monetary base and the refinance rate, these two policies lead to similar outcomes in a deterministic setting: a higher monetary base is associated with a lower refinance rate; either policy leads to a lower interest rate and a higher money stock in monetary equilibrium[5].

[5] It should be noted that the economic implications of the two policies are in general different in a stochastic setting in which demand and supply can shift up and down because the impact of shocks on the monetary system may vary.

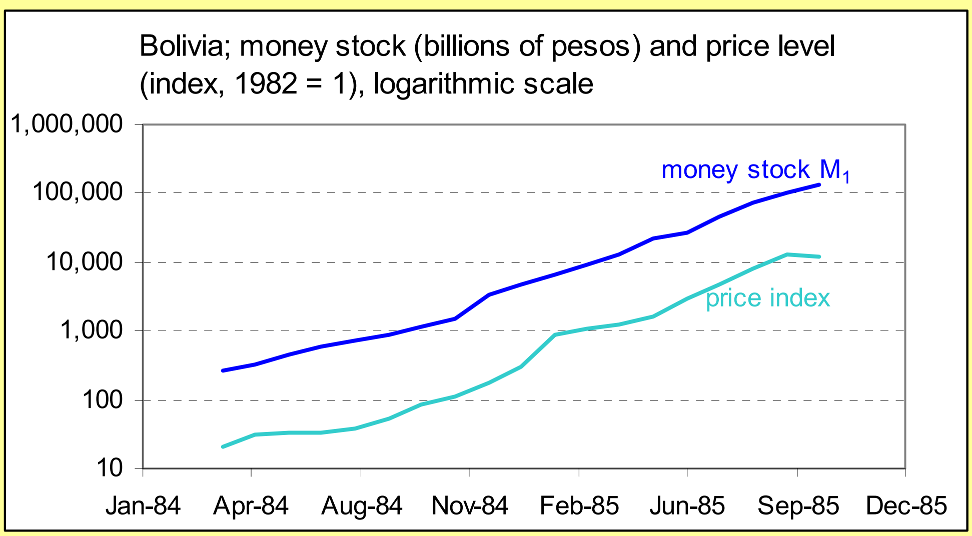
Box 1.3 Money and prices under hyperinflation

Under extreme circumstances, such as hyperinflation, the impact of the real interest rate and real income level on the demand for money may become negligible. The term hyperinflation refers to periods of very high inflation rates in which money loses its value very rapidly. Philip Cagan (1956) identified hyperinflation as a period in which the inflation rate is at least 50 percent per month. This happened, for example, in Bolivia in 1984 and 1985, with a monthly peak of 183 percent inflation from January 1985 to February 1985. In September of 1985 prices were 600 times as high as they were in April of 1984. Under these conditions, Cagan argued that the demand for money simplifies to:

(1.10) $$\ln(m_t) = -\gamma \pi_t^e ,$$

where γ is a semi-elasticity parameter and π_t^e is the expected inflation rate. To estimate such a function, one would of course need a theory of expectation formation. However, the growth rate of the money stock and the rate of inflation can be effectively illustrated in a logarithmic graph as the slope of the money stock and the slope of the price index, respectively. This is illustrated in Figure 1.7.

Figure 1.7 Money and prices under extreme circumstances



Calculations based on Morales (1988, Table 7A1).

As is evident from the slopes of the curves in Figure 1.7, the expectations are initially lagging a bit behind realizations as the money stock is growing more rapidly than the price level (May-August 1984). Then expectations are rapidly catching up with realizations (inflation is higher than money growth) until the inflation peak in February 1985 shows that prices have increased too rapidly. The Bolivian government introduced a drastic stabilization plan at the end of August 1985, reducing the increase in the money stock from 70 percent, to 57 percent, to 39 percent, and to 28 percent in the months July-October 1985. With some lag the price level followed suit, with inflation rates of 66 percent, 66 percent, 57 percent, and -2 percent in that same period. Apparently, the economy became convinced by October 1985 that the government was serious in its efforts to reduce hyperinflation.

1.7 Conclusions

We briefly discussed the basics of the money market. Money is used as a means of payment, a store of value, and a unit of account. We identified different types of money (from narrow to broad: monetary base, M_1, M_2, and M_3), but will henceforth focus on the money stock M_1 in our discussions unless explicitly stated otherwise. Money is supplied by the banking system (central bank plus commercial banks), which in the aggregate responds to price signals, notably the interest rate. The demand for money depends positively on income (transactions demand) and negatively on the interest rate (opportunity cost or the price for holding money). The interaction of these forces determines the monetary equilibrium, that is the interest rate and the money stock. The central bank can use various policies to influence this equilibrium; a tighter monetary policy implies higher interest rates and a lower money stock. The building blocks of monetary equilibrium discussed in this chapter will be used throughout the sequel.

Chapter 2 Foreign exchange markets

Objectives / key terms

spot exchange rate	bid, ask, and spread
appreciation and depreciation	(triangular) arbitrage
black and parallel markets	forward, swap, option, and swaption
plain vanilla	hedging and speculation
effective exchange rates	trading volume
intervention	brokers

We provide an introduction to foreign exchange markets, by discussing different types of exchange rates and instruments (spot, forward, swap, and option), the main players on the foreign exchange markets (commercial banks, firms, other financial institutions, and central banks), and the size and composition of these markets.

2.1 Introduction

Most international transactions, such as the international trade of goods and (tourist) services or international investment activities, involve the exchange of one currency for another. The most noteworthy, and rather recent, exception to this rule is the international exchange between the countries of Europe's Euro area (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain), which have decided to introduce one common currency on 1 January 1999: the euro. The trade of different currencies takes place on the foreign exchange markets, at prices called exchange rates. This rarely involves the exchange of bank notes between citizens, except in the case of tourism or illegal (drugs) trade. Instead, most foreign exchange involves the trade of foreign-currency-denominated deposits between large commercial banks in international financial centres, such as London, New York, and Tokyo. There are different types of exchange rates and instruments, such as spot rates, forward rates, swaps, and options. We begin our discussion with the spot exchange rate market.

2.2 Spot exchange rates

It is important to realize that an exchange rate is a price, namely the price of one currency in terms of another currency. As there are many countries with convertible currencies, there are many exchange rates, such as the exchange rate of a Singapore dollar in terms of European euros or the exchange rate of a Japanese yen in terms of British pounds. Since the exchange rate is a price, a rise in the exchange rate indicates that the item being traded has become more expensive, just like any other price rise indicates. Therefore, if the exchange rate of a Singapore dollar in terms of European euros rises, this indicates that the Singapore dollar has become more expensive. Various specialized symbols have been introduced to identify specific currencies, such as $ to denote (US) dollars, € to denote European euros, £ to denote (British) pounds, and ¥ to denote (Japanese) yen. Table 2.1 lists some of these international currency symbols. The table also lists the three letter international standard (ISO) code to identify the currencies.

Table 2.1 Some international currency symbols

Country	Currency	Symbol	ISO code
Australia	dollar	A$	AUD
Canada	dollar	C$	CAD
China	yuan		CNY
EMU countries	euro	€	EUR
India	rupee	Rs	INR
Iran	rial	RI	IRR
Japan	yen	¥	JPY
Kuwait	dinar	KD	KWD
Mexico	peso	Ps	MXP
Saudi Arabia	riyal	SR	SAR
Singapore	dollar	S$	SGD
South Africa	rand	R	ZAR
Switzerland	franc	SF	CHF
United Kingdom	pound	£	GBP
United States	dollar	$	USD

As discussed below, there are various types of exchange rates, but we first focus attention on the *spot* exchange rate, the price of buying or selling a particular currency at this moment. Table 2.2 lists some spot exchange rates as recorded on 13 September 2004, at 1.39AM ET. The fact that we have to be so precise by listing not only the day on which the spot exchange rates were recorded, but also the exact time and the time zone signals an important general property of exchange rates: they are variable. In fact, exchange rates are *extremely variable*: only a few minutes later all quoted prices for the spot exchange rates deviated from the data reported in Table 2.2. This makes exchange rates rather special prices, as the variability in the quoted prices is much higher than for goods and services traded on the market place (such as the price of diapers in the supermarket), although generally of the same order of magnitude as many other prices in financial markets. In the chapters to follow, we will on the one hand have to explain the high variability of exchange rates relative to most other prices, and on the other hand use this information for macroeconomic modelling.

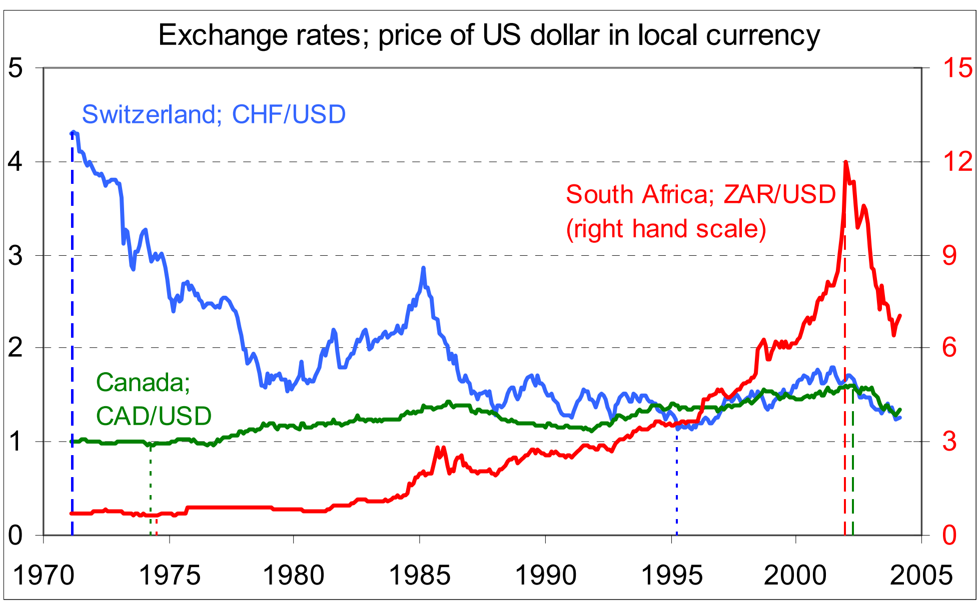
Table 2.2 Some spot exchange rates on 13 September 2004, at 1.39AM ET

price of	bid spot rate	ask spot rate	in terms of currency	country	spread %
1 USD	1.2905	1.2908	CAD	Canada	0.0232
1 USD	1.2575	1.2581	CHF	Switzerland	0.0477
1 USD	6.52	6.57	ZAR	South Africa	0.7669

Source: http://finance.yahoo.com

Table 2.2 lists the exchange rate of the US dollar in three countries, namely Canada, Switzerland, and South Africa. There are actually two rates quoted: (i) the *bid* rate, that is the price at which banks are willing to buy one US dollar (what they are bidding for one dollar), and (ii) the *ask* rate, that is the price at which the banks are willing to sell one US dollar (what they are asking to sell you one dollar). These quotes are for large amounts only (1 million dollars or more). The difference between the buying and selling rate is called the *spread*. It generates revenue for the currency trading activities of the banks. In practice, the spread is quoted relative to the bid price. So, based on Table 2.2 a Swiss bank might quote USD 1.2575-81, indicating the bank is willing to buy dollars at 1.2575 and willing to sell dollars at 1.2581. Obviously, banks from other countries can also buy and sell US dollars for Swiss francs, that is trading in these currencies is not only limited to Swiss and American banks. Note that the spread between the bid price and the ask price, the margin for the banks, is very small. For the US dollar – Swiss franc in our example it is only 0.0477 percent ($=100\% \times (1.2581-1.2575)/1.2575$). As shown in Table 2.2, the spread is even smaller for trade in the US – Canadian dollar (0.0232 percent), but larger for trade in the US dollar – South African rand (0.7669 percent). In general, the spread is quite small and decreases with the intensity with which the two currencies involved are traded, suggesting that the American and Canadian dollar are more frequently traded than the American dollar and the Swiss franc, which are in turn more frequently traded than the American dollar and the South African rand.[6] Since the spread is so small, most of the remainder of this book will assume that the bid price is equal to the ask price (such that the spread is zero) and speak of *the* exchange rate of the US dollar in terms of Canadian dollars, Swiss francs, or South African rands.

Figure 2.1 Some exchange rates, monthly data



Data: IFS; Noon NY exchange rates; dashed lines indicate minimum and maximum values

[6] In the most recent BIS triennial survey using data of April 2001 this was, in fact, the case. Trading volume in million US dollar per day of local currency relative to the US dollar was 25,177 for Canada,

Figure 2.1 illustrates the variability of exchange rates for a longer time period (1971-2004) for the exchange rate of the US dollar in Canada, South Africa, and Switzerland using monthly data. There are clearly big differences in the price of the US dollar over time, as well as big differences in variability between countries. In Canada, for example, the US dollar exchange rate varied from a low of 0.9596 on 1 May 1974 to a 67 percent higher value of 1.5995 on 1 April 2002 (see the dashed lines in Figure 2.1). In South Africa, on the other hand, the US dollar exchange rate varied from a low of 0.6678 on 1 August 1974 to a 1,697 percent higher value of 12 on 1 January 2002. Over the period as a whole, the US dollar has *appreciated*, that is has become more expensive, relative to the Canadian dollar and the South African rand. There are, however, sub periods within this time frame in which the US dollar *depreciated*, that is became less expensive, relative to the Canadian dollar and South African rand, most notably in South Africa after 1 January 2002. Similarly, for the period as a whole the US dollar has depreciated relative to the Swiss franc, although there are (long) sub periods in which the US dollar appreciated relative to the Swiss franc, notably in the period 1979-1985.

Table 2.3 Cross exchange rates; spot, 1 February 2004

		in terms of			
price of 1	(country)	CAD	CHF	USD	ZAR
CAD	(Canada)	1.0000	0.9434	0.7471	5.2671
CHF	(Switzerland)	1.0599	1.0000	0.7919	5.5828
USD	(United States)	1.3385	1.2628	1.0000	7.0500
ZAR	(South Africa)	0.1899	0.1791	0.1418	1.0000

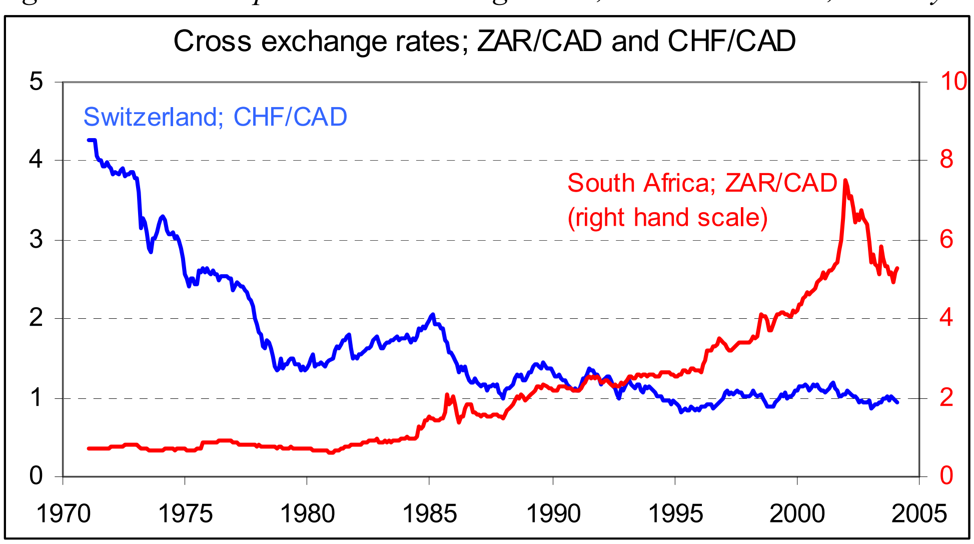
Data source: see Figure 2.1; for ISO code see Table 2.1; based on price of US dollar (shaded)

We have seen that exchange rates vary considerably over time, even within one day. The same is *not* true for the exchange rate at different locations for a given point in time. Since currencies are homogenous goods (a yen is a yen, no matter where it comes from) and the spreads are very small, if the Japanese yen exchange rate would be high in one

18,644 for Switzerland, and 7,775 for South Africa, see BIS (2002, Table E.7, p. 64) and section 20.6. Other factors, such as the expected variability of the exchange rate, also affect the spread.

location, say New York, and low in another location, say London, at the same point in time, traders could make a profit by (electronically) rapidly buying yen in London (where they are cheap) and selling them in New York (where they are dear). As a result of this *arbitrage* activity, the price of yen would rise in London and fall in New York. Profit opportunities exist until the price is equal in the two locations. In view of the small spreads, the ability to swiftly move large funds around the globe electronically, and the huge trading volume (see section 2.6), equality occurs almost instantaneously. This does not only hold for direct arbitrage for a particular exchange rate, but also for so-called *triangular arbitrage* for different pairs of exchange rates. This is illustrated in Table 2.3. Suppose we know the price of one US dollar at noon on 1 February 2004 in terms of Canadian dollars (1.3385), Swiss francs (1.2628), and South African rand (7.0500). In view of arbitrage opportunities, this suffices to calculate all cross exchange rates as given in Table 2.3. We know, for example, that one Swiss franc must cost 5.5828 South African rand, because 7.0500 rands is worth one US dollar, which in turn is worth 1.2628 Swiss francs, so that 7.0500 rands is worth 1.2628 Swiss francs, or one Swiss franc is worth $7.0500/1.2628 = 5.5828$ rands. Similarly for the other entries in Table 2.3. Figure 2.2 illustrates the evolution of the implied cross exchange rate of the Canadian dollar in terms of the Swiss franc and South African rand based on the data used for Figure 2.1.

Figure 2.2 Some implied cross exchange rates; Canadian dollar, monthly data



Data source: see Figure 2.1

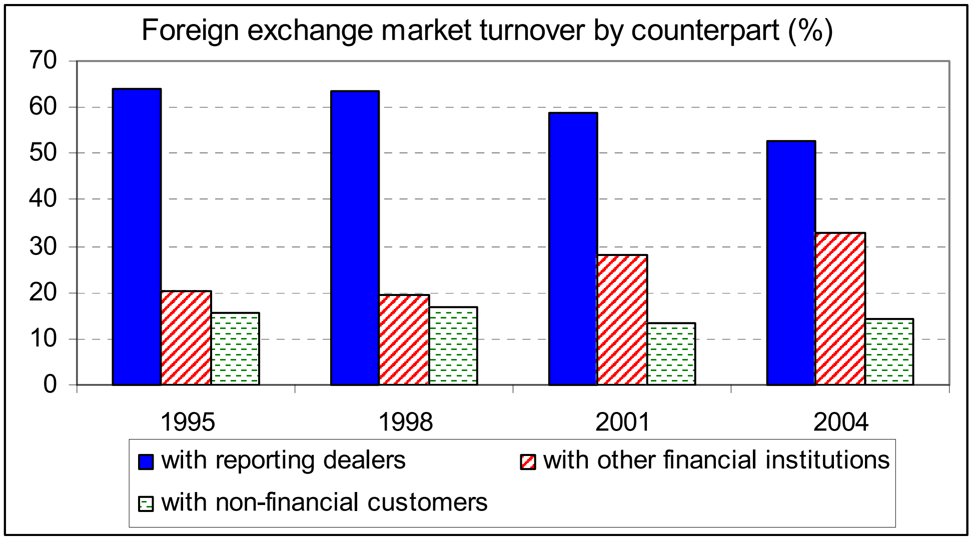
2.3 Players and markets

The main players on the foreign exchange market are commercial banks, firms, nonbank financial institutions, and central banks. Individuals, such as tourists, may of course also participate on the foreign exchange market, but these transactions constitute only a very small fraction of the total market. We therefore concentrate on the other players:

- *Commercial banks*; all major international transactions involve the debiting and crediting of accounts at commercial banks, that is most transactions relate to the exchange of bank deposits (in different locations and denominated in various currencies). This puts commercial banks at the centre of the foreign exchange market. Banks perform the role of intermediary for their clients (mostly firms) by bringing together their demands and supplies, either directly or indirectly through trade with other banks (interbank trading). The latter accounts for most of the market activity, see Figure 2.3.
- *Firms*; the international exchange of goods and services by firms, either related to inputs, final goods, or intermediate (capital) goods and services, almost always involves foreign exchange trading to pay for these activities. Firms contact their banks to take care of these payments.
- *Nonbank financial institutions*; as a result of financial deregulation, foreign exchange transactions are also offered to the public by nonbank financial institutions. Large pension funds and other institutional investors are active participants on the foreign exchange market.
- *Central Banks*; depending on various macroeconomic circumstances, such as the unemployment rate, the growth rate of the economy, the inflation rate, and explicit or implicit government policies, the central bank of a country may decide to buy or sell foreign exchange. Although the size of these central bank *interventions* is usually relatively modest, its impact can be substantial as the other players in the market may view these interventions as indicative of other future macroeconomic policy changes.

The Bank for International Settlements (BIS, see chapter 5) conducts a triennial survey of the foreign exchange market by gathering detailed information every three years for the month of April. Based on this information, Figure 2.3 illustrates that most trading activity on the foreign exchange market takes place between the reporting traders (brokers). Its share in the total is, however, gradually declining (from 64 percent of the total in 1995 to 53 percent in 2004). Trade with other financial institutions has increased (from 20 per cent in 1995 to 33 per cent in 2004). The rest of the trading activity is relative to non-financial customers. Its share in the total is relatively stable.

Figure 2.3 Foreign exchange market turnover by counterparty (% of total turnover)



Source: BIS (2004)

Although currencies can be bought and sold openly on the foreign exchange market in many countries, there are also many other (mostly developing) countries imposing a range of restrictions on currency trading. Sometimes you need a government licence to trade, sometimes the amount you can trade is limited, sometimes there is a time limit within which received foreign currency must be sold to the central bank, and sometimes it is simply forbidden for individuals and firms to use foreign currency. As a result of these legal restrictions on foreign exchange transactions, it is almost inevitable for illegal *black markets* for currency trading to develop and meet the demand of individuals and firms. Obviously, the exchange rate on the black market will deviate from the official exchange rate on the market permitted and controlled by the government, which creates a powerful (illegal) arbitrage incentive for those allowed to trade on the official market. Quite frequently, the black market rate, which fluctuates daily, is a better indicator for the 'appropriate' (market clearing) exchange rate than the official rate, which tends to be fixed for longer time periods. This was the case, for example, in Guatemala with an artificial official exchange rate of one quetzale per dollar for more than three decades. In the case of Guatemala, however, the government allowed the black market to operate quite openly (next to the post office) as an alternative to the official exchange market. Such a market is called a *parallel market*.

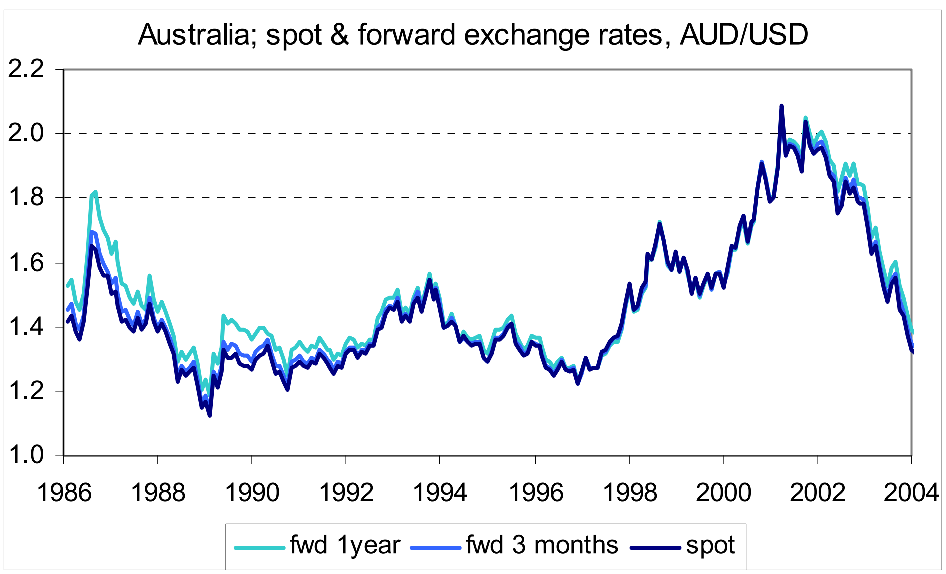
2.4 Forward looking markets

The large variability of exchange rates illustrated in Figure 2.1 potentially poses problems for agents active on the foreign exchange market. Suppose, for example, that you represent a Japanese firm and have sold a thousand watches for delivery and payment in France in three months time at a total price of € 150,000. At the current exchange rate of ¥ 133.49 per euro, the payment of € 150,000 is worth ¥ 20,023,500. Since the total cost of producing and delivering the watches for your company is about 19 million Japanese yen, you stand to make a profit of about 1 million yen on this transaction, so your boss will be pleased. However, payment (in euro) takes place only three months later. To your surprise and dismay, the euro turns out to have considerably depreciated relative to the Japanese yen in this period, such that three months later the spot exchange rate for the euro is only ¥ 133.49. The payment of € 150,000 is now worth only ¥ 18,051,000, which means that your company made a loss of about one million yen, rather than a profit of one million yen. Your boss is not pleased.

Could you have avoided the one million yen loss? Yes, you could have, but it required you to take action three months earlier on a forward looking market using a forward looking instrument. In this case, for example, you could have sold the € 150,000 on the forward exchange market three months earlier at a then-agreed-upon forward price of, say ¥ 131.24 per euro. This would have *guaranteed* you a revenue of ¥ 19,686,000 upon payment and ensured a profit of about 700,000 Japanese yen. That is, you could have *hedged* your foreign exchange risk exposure on the forward exchange market. Since many other economic agents face exposure to similar or opposite foreign exchange risks (which they would like to hedge) and other economic agents would like to take a gamble (*speculate*) on the direction and size of changes in the exchange rate, a whole range of forward looking markets has developed, with associated rather exotic terminology. We can distinguish, for example, between three so-called *plain vanilla* instruments, namely *forwards*, *swaps*, and *options*. According to the BIS (2002, p. 34), the term plain vanilla refers to instruments "which are traded in generally liquid markets according to more or less standard contracts and market conventions." Combinations of the basic instruments can then be used to construct tailor-made financial instruments, such as currency *swaptions* (options to enter into a currency swap contract), etc.

The spot exchange rate is the price at which you can buy or sell a currency today. The forward exchange rate is the price at which you agree upon today to buy or sell an amount of a currency at a specific date in the future.[7] A swap involves the *simultaneous* buying and selling of an amount of currency at some point in the future and a *reverse* transaction at another point in the future. A currency swap applies this to a stream of profits. Finally, an option gives you the right to buy or sell a currency at a given price during a given period. Formal definitions of these instruments are given in Technical Note 2.1.

Figure 2.4 Australia – US; spot and forward exchange rates of US dollar



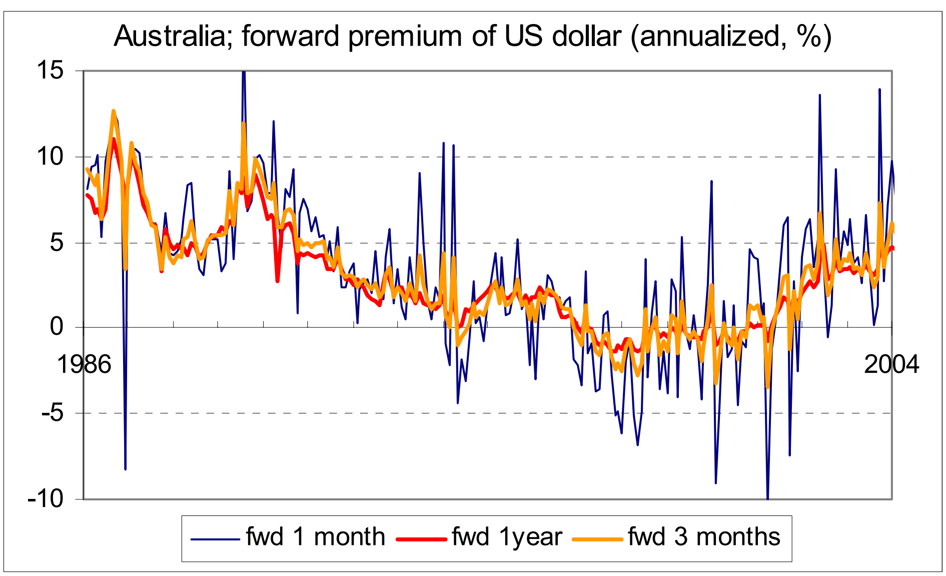
Data source: see Figure 2.1

[7] The *futures* market is slightly different from the forward market in that only a few currencies are traded, with standardized contracts at certain locations (such as the Chicago Mercantile Exchange, the largest futures market) and specific maturity dates.

Figure 2.4 illustrates the movement of the spot and forward exchange rates of the US dollar relative to the Australian dollar in the period 1986-2004. Obviously, the forward rate and the spot rate move, in general, quite closely together. However, there are times (such as 1997-2001) in which spot and forward are very close together and other times (such as 1986-1993) at which spot and forward rate are pretty far apart (particularly for the longer one year forward rate). Most of the time, the forward rate of the US dollar was higher than the spot rate, that is the US dollar was selling at a *premium*. If the opposite holds, that is if the forward rate is below the spot rate, the currency is said to be selling at a *discount*. We will later emphasize that the existence of a forward premium is driven by an expected appreciation of the currency, while a forward discount is driven by an expected depreciation of the currency. To get a better (and comparable) view of the degree to which the US dollar was selling at a premium or a discount in this period, we can calculate the annualized forward premium for different maturities. Let S denote the spot exchange rate, F the forward rate, and let the duration be measured in months. Then this is given by:

$$(2.1) \qquad Forward\ premium\Big|_{annual,\%} = \frac{(F-S)/S}{duration/12}$$

Figure 2.5 Australia – US; forward premium of US dollar



Data source: see Figure 2.1

Figure 2.5 illustrates the forward premium for different maturities. It shows that the variability of the one month forward premium is much higher than the forward premium for 3 months or one year. It also shows that the changes from one period to the next can be quite large, that the predicted percentage change of appreciation or depreciation (as measured by the forward premium) can be substantial (up to 10 percent per year, with a peak of 18 percent for the one month rate), and that the forward premium is in general in the same direction for different times to maturity. The latter indicates that it is in general not expected for a currency to depreciate in the short-run and appreciate in the long-run, or vice versa.

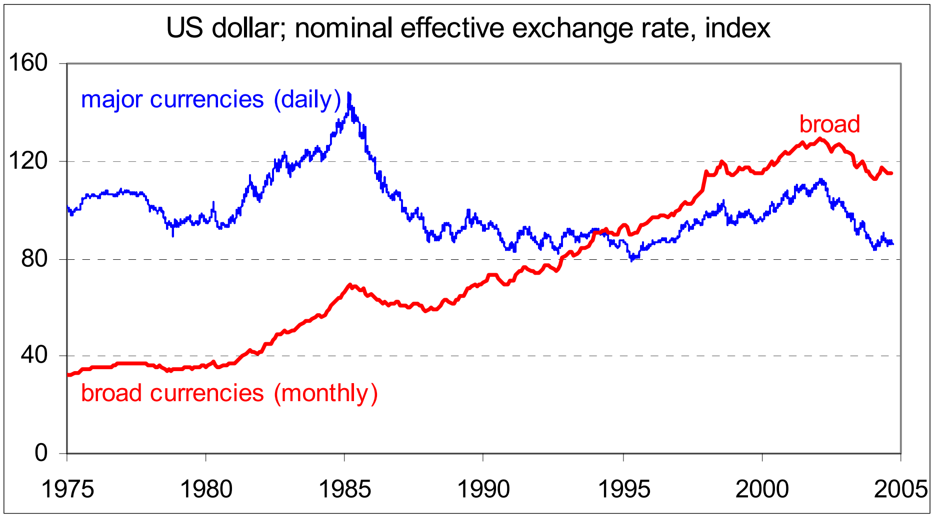
2.5 Effective exchange rates

As illustrated in Figure 2.1 for the US dollar relative to the Canadian dollar, the South African rand, and the Swiss franc, most of the time a currency is appreciating relative to some currencies and simultaneously depreciating relative to some other currencies.[8] The question then arises whether the currency has actually become more valuable or less valuable over time. The precise and correct, but cumbersome, answer is, of course, that it depends on the currency used for comparison. It is, however, frequently useful to distil the divergent movements in (bilateral) exchange rates into a key (index) number summarizing the overall movement of a country's exchange rate. Such an index is called an *effective* exchange rate. As with the design of any index number, its construction (involving decisions on which currencies to include and how to weigh them) depends on the specific purpose for which it is used. The US Federal Reserve, for example, calculates six effective exchange rates for various policy purposes on a regular basis. There is: (i) a 'broad' index, focusing on the value of the dollar relative to all foreign countries with a share in US trade of at least 0.5 percent, (ii) a 'major' index, focusing on the value of the dollar relative to the major international currencies from the Euro area, Canada, Japan, U.K., Switzerland, Sweden, and Australia, and (iii) an 'OITP' index, focusing on the value of the dollar relative to other important trading partners (OITP). For all three indices, a *nominal* and a *real* effective exchange rate are calculated. The real exchange

[8] Obviously, at any moment in time there is always at least one currency non-appreciating relative to all other currencies and at least one currency non-depreciating relative to all other currencies.

rates involves (changes in) the price levels in different countries. Since it is extensively discussed in the next chapter, this section focuses on the nominal effective exchange rate.

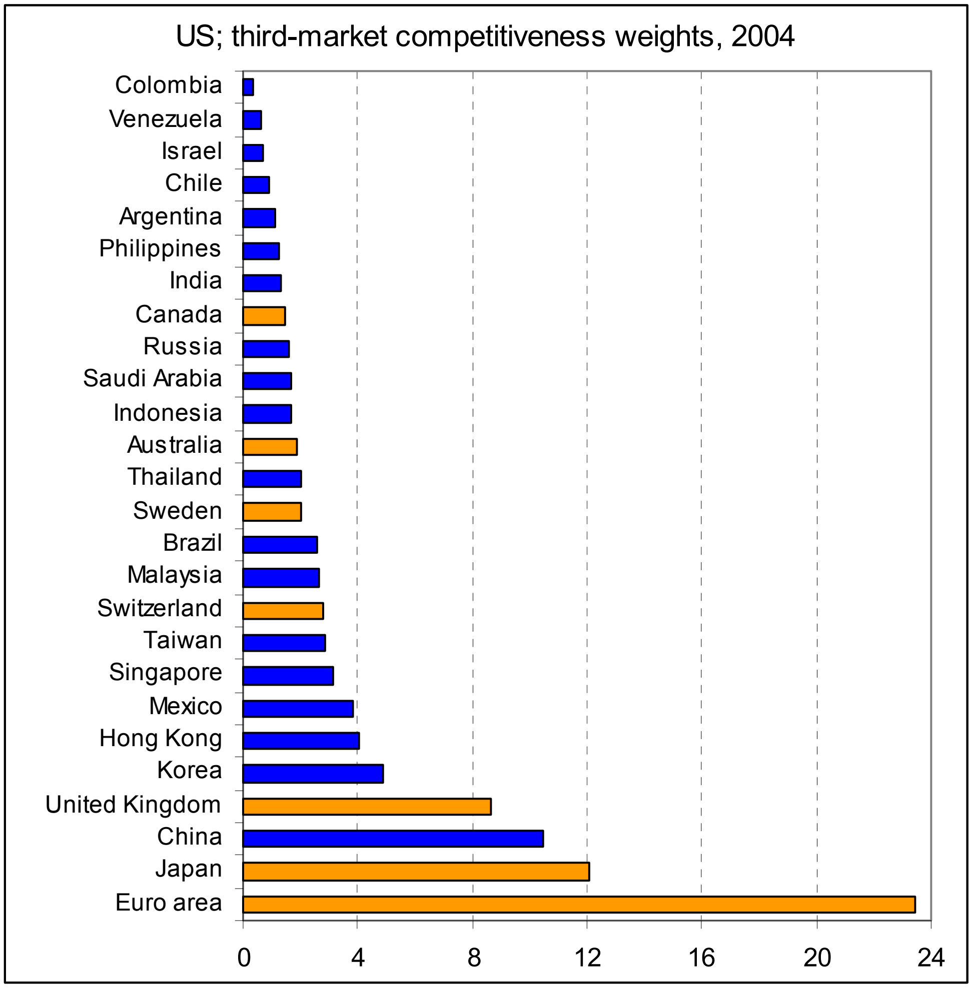
Figure 2.6 USA, nominal effective exchange rate



Data source: www.federalreserve.gov; see the main text for 'major' and 'broad' index.

Figure 2.6 illustrates the value of the US dollar relative to the major international currencies (using daily data) and relative to the broad index of major US trading partners (using monthly data). Clearly, the nominal broad index moves quite differently from the major currency index. The latter moves up and down over time without a clear trend, whereas the former moves up most of the time. This difference is caused by the inclusion of some high-inflation countries in the broad index (see also chapter 3). As Leahy (1998, p. 812) puts it: "The inclusion of such countries restricts the usefulness of the nominal versions of these indexes to analysis of shorter-term developments in foreign exchange markets because, over the longer term, large nominal depreciations of a few currencies swamp information on the value of the dollar against other currencies."

*Figure 2.7 US; third-market competitiveness weights, 2004**



Data source: www.federalreserve.gov ; * light shaded countries are used for the 'major' index

The exchange rate indices illustrated in Figure 2.6 are calculated as follows:[9]

(2.2) $I_t = I_{t-1} \prod_j (S_{j,t} / S_{j,t-1}) w_{j,t}$,

where I_t is the value of the index at time *t* (usually put equal to 100 for some benchmark year), $S_{j,t}$ is the spot rate (price) of the US dollar in terms of currency *j* at time *t*, and $w_{j,t}$ is the weight of currency *j* at time *t*. An increase of the index therefore indicates that the dollar is becoming more expensive 'on average', that is it appreciates 'on average.' Various methods are used to construct the (time-varying) weights $w_{j,t}$. A simple method

[9] The symbol $\prod_j$ denotes the product over the index *j*; so, for example, $\prod_{j=1}^4 a_j = a_1 \cdot a_2 \cdot a_3 \cdot a_4$. It is therefore similar to the summation symbol $\sum_j$, but then for products.

would just use the share of a currency in the country's exports, imports, or total trade. The Federal Reserve uses a more complicated procedure based on the share of a foreign country's goods in all markets that are important to U.S. producers to derive third-market competitiveness weights, see Leahy (1998) for details. Figure 2.7 illustrates these weights for the year 2004 (see also the next chapter). By far the greatest weight (23.4 percent) is given to the Euro area countries, followed by Japan (12.1 percent), China (10.4 percent), the U.K. (8.6 percent), and South Korea (4.9 percent). Obviously, similar nominal effective indices for other countries use other weights, based on the differences in the extent to which changes in other currencies are important for that specific country.

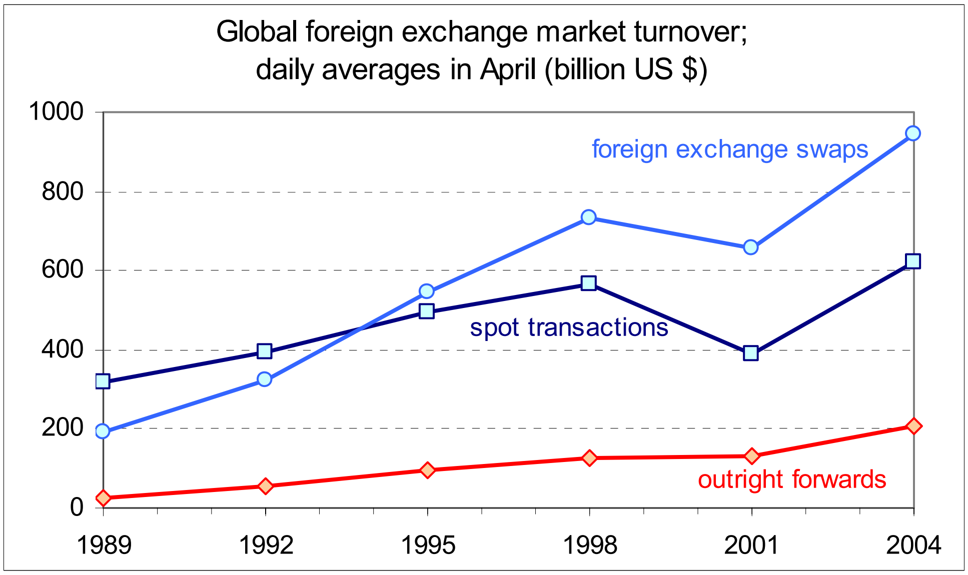
2.6 Trading volume

The foreign exchange market is the largest financial market in the world. In April 2004, average turnover was $ 1,900 billion *per day*. Just pause for a moment to appreciate the enormous sums of money being transferred daily on the foreign exchange market. This large volume is one of the main reasons for the low spreads, as illustrated in Table 2.2.

Box 2.1 The power of foreign exchange markets

In the popular press you will sometimes see comparisons of the daily turnover on the foreign exchange market or of multinationals with the GDP levels of some countries, usually with the intention to suggest that individual countries are small and powerless compared to global financial market forces. To a fair degree that is, of course, nonsense. Not only because sovereign states have enormous (legislative) powers beyond that of any individual firm, but also because GDP is a *value added* measure that should not be compared with turnover in financial markets. The total production value of the financial services sector in the Netherlands in 2003, for example, was only equal to 6.7 percent of Dutch GDP (CBS, 2004, p. 46). This number includes the entire banking sector, the insurance companies, and other financial services. The value added created on the foreign exchange market is therefore only a fraction of that 6.7 percent. Obviously, the capital flows on the foreign exchange markets are large and, as we will see in the sequel, can be powerful at times, but we should keep the fraction of the financial services sector in the economy in general (and the fraction of the foreign exchange market in particular) in proper perspective.

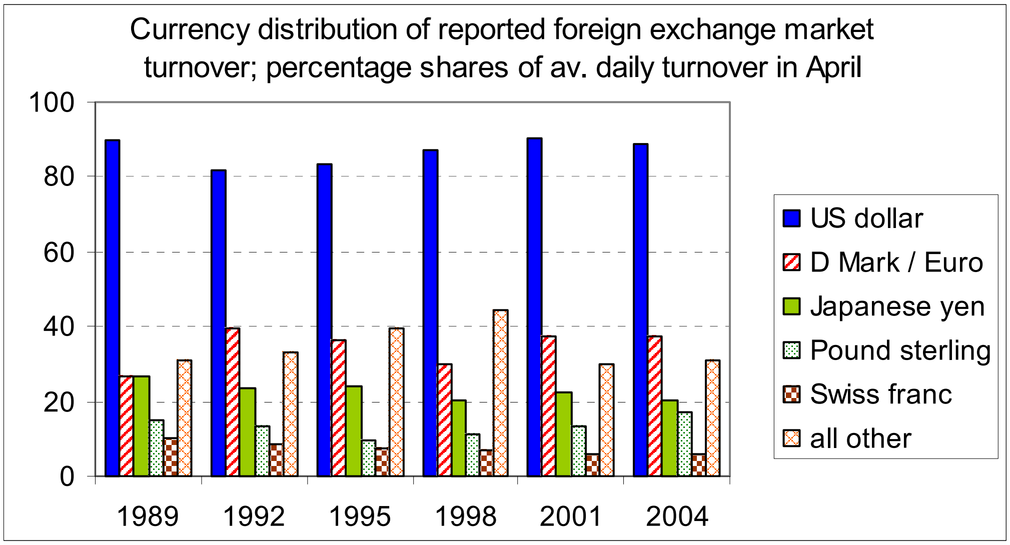
Figure 2.8 Global foreign exchange market turnover



Data source: BIS (2004), triennial central bank survey

Figure 2.8 illustrates the changes in the composition of the foreign exchange turnover for the six triennial surveys. Foreign exchange swaps are the most traded instruments, overtaking the spot transactions market in volume sometime in between 1992 and 1995. Outright forwards constitute a relatively small market by comparison. The figure also illustrates that the traded volume on the foreign exchange market fell for the first time since the surveys started in 2001, most notably in the spot market. This reduction, followed by a rapid increase of 57 per cent in the period 2001-2004, can be contributed largely to the introduction of the euro, which eliminated intra-EMS trading (see Ch. 31).

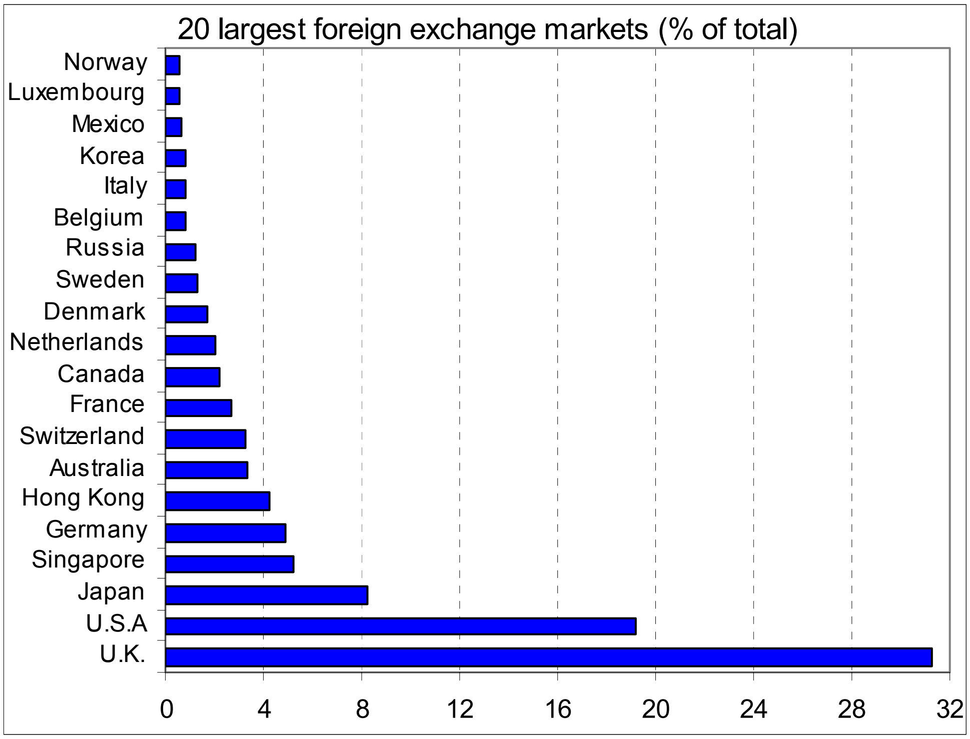
*Figure 2.9 Five most used currencies on the foreign exchange market**



Data source: BIS (2004); * Because two currencies are involved in each transaction, the sum of the percentage shares of individual currencies totals 200 percent instead of 100 percent.

The US dollar is the most traded currency on the foreign exchange market, followed by the euro, the Japanese yen, the pound sterling, and the Swiss franc. Figure 2.9 illustrates the changes in the shares of these five most traded currencies, taking the share of the Deutsche Mark as indicative of the importance of the euro prior to its introduction. The dollar – euro pair was by far the most traded currency pair in 2004, capturing 28 percent of global turnover, followed by dollar – yen (17 percent) and dollar – sterling (14 percent), see BIS (2004, p. 1). For historical reasons which provided a first-mover advantage, the United Kingdom (London) is by far the largest foreign exchange market, capturing 31.3 percent of total turnover, followed by the United States (New York; 19.1 percent) and Japan (Tokyo; 8.3 percent). This is illustrated in Figure 2.10 for the twenty largest foreign exchange markets in the world.

Figure 2.10 Twenty largest foreign exchange markets, April 2004



Data source: BIS (2004)

Finally, we should point out that the over-the-counter (OTC) derivatives market involves transactions between two financial institutions outside of the regular market, for example if the Dutch ABN bank calls the American Citibank to make a deal. This market consists of interest rate derivatives contracts and non-traditional foreign exchange derivatives (such as cross-country currency swaps and options). It has been growing very rapidly for quite some time now, to reach an average daily turnover of $ 1,200 billion in April 2004.[10]

2.7 Conclusions

With a daily turnover of $ 1,200 billion in 2001, the foreign exchange markets are the world's largest financial markets. The largest foreign exchange markets are located in London, New York, and Tokyo, respectively. The most important players are commercial banks (through intermediaries called *brokers*), firms, nonbank financial institutions, and

[10] Activity in the foreign exchange and OTC markets cannot be directly compared as a result of differences in characteristics and uses of products.

central banks. The most traded currencies are the US dollar, the euro, the Japanese yen, and the British pound sterling.

There are different types of exchange rates and instruments, such as spot rates, forward rates, swaps, and options. The difference between the banks's buying (bid) and selling (ask) exchange rate is called the spread. In view of the large traded volume, the spread is usually quite small. We will mostly put the spread equal to zero in the forthcoming chapters, speaking of *the* (bilateral) exchange rate between two currencies, which is the price of one currency in terms of another currency. Exchange rates are characterized by a high variability, changing from one day to another, and even from minute to minute. On the one hand this variability will have to be explained. On the other hand it will be used for macroeconomic modelling.

As a consequence of the high variability of exchange rates, a given currency (such as the euro) usually appreciates relative to some currencies and simultaneously depreciates relative to some other currencies. To summarize these divergent bilateral movements, it is useful for policy purposes to calculate an index, called an effective exchange rate, of that currency relative to a weighted basket of a range of other currencies. As a result of international arbitrage, the same currency sells for (virtually) the same price at different locations at the same point in time. This also holds for cross exchange rates as a result of triangular arbitrage, involving the exchange of three currencies. If the forward rate of a currency, which is the forward price of the currency, is higher than the spot rate, the currency is sold at a premium. Otherwise, it is sold at a discount. After this chapter introducing the various foreign exchange markets, we are ready to investigate some of the underlying economic forces governing these markets (namely purchasing power parity and interest rate parity) in the next two chapters.

Technical Note 2.1 Formal definitions

The Bank for International Settlements gives the following definitions for the main instruments in its triennial survey (BIS; 2002, p. 35):

- *Spot transaction*; single outright transaction involving the exchange of two currencies at a rate agreed on the date of the contract for value or delivery (cash settlement) within two business days.
- *Outright forward*; transaction involving the exchange of two currencies at a rate agreed on the date of the contract for value or delivery (cash settlement) at some time in the future (more than two business days later).
- *Foreign exchange swap*; transaction which involves the actual exchange of two currencies (principal amount only) on a specific date at a rate agreed at the time of conclusion of the contract (the short leg), and a reverse exchange of the same two currencies at a date further in the future at a rate (generally different from the rate applied to the short leg) agreed at the time of the contract (the long leg).
- *Currency swap* (including cross-currency swap); contract which commits two counterparties to exchange streams of interest payments in different currencies for an agreed period of time and to exchange principal amounts in different currencies at a pre-agreed exchange rate at maturity.
- *Currency option/warrant*; option contract that gives the right to buy or sell a currency with another currency at a specified exchange rate during a specified period.

Chapter 3 Purchasing power parity

Objectives / key terms

Law of One Price	absolute and relative version
Purchasing Power Parity (PPP)	real (bilateral) exchange rate
real effective exchange rate	transaction costs
differentiated goods	fixed investment and thresholds
non-traded goods	Harrod-Balassa-Samuelson effect
PPP corrections	endogenous and exogenous

We discuss absolute and relative versions of the Law of One Price (for individual goods) and purchasing power parity (PPP, for price indices). There can be substantial short-run deviations from PPP, but in the long-run relative PPP holds remarkably well because fundamentals and arbitrage are dominant long-run economic forces.

3.1 Introduction

According to the Law of One Price identical goods should (under certain conditions) sell for the same price in two different countries at the same time. It is the foundation for purchasing power parity (PPP) theory, which relates exhange rates and price levels. The absolute PPP exchange rate equates the national price levels in two countries if expressed in a common currency at that rate, so that the purchasing power of one unit of a currency would be the same in the two countries. Relative PPP focuses on changes in the price levels and the exchange rate, rather than the level. Although the term purchasing power parity was apparently first used by Cassel (1918), the ideas underlying PPP have a history dating back at least to scholars at the University of Salamanca in the 15th and 16th century, see Officer (1982). As we will see, long-run relative PPP holds remarkably well, even though there can be substantial short-run deviations from relative PPP. Many structural models that seek to explain exchange rates and exchange rate behaviour are based on this presumption, leading Rogoff (1992) to conclude that most international economists "instinctively believe in some variant of purchasing power parity as an anchor for long-run real exchange rates."

3.2 The Law of One Price and Purchasing Power Parity

Suppose that the exact same product, say a computer chip, is freely traded in two different countries, say America (sub index *A*) and Britain (sub index *B*). Suppose, furthermore, that there are no transportation costs, no tariffs, no fixed investments necessary for arbitrage, and no other impediments to trade flows between these two countries of any type whatsoever. Should not, under those conditions, the (appropriately measured) price of the computer chip in Britain be the same as in America? According to the *Law of One Price*, it should. Obviously, we have made a range of assumptions before we came to the conclusion that arbitrage should ensure that the Law of One Price holds. Any violation of these conditions can, in principle, cause a violation of this law. We discuss these issues in the second part of this chapter.

There are, actually, different versions of the Law of One Price. There is a strong *absolute* version and a weaker *relative* version. Both can be applied to individual products and to price indices. Let's start with the strongest version of all. Suppose we have a large number N of individual products consumed and produced in America and Britain (computer chips, flour, cars, movies, etc.). We let the sub index i denote the type of product (so i ranges from 1 to N) and the sub index t denote time (which could, for example, be quarters, months, or days). Then the absolute version of the Law of One Price for each individual good i implies:

(3.1) $$P_{Bi,t} = S_t \, P_{Ai,t} \;, \quad i = 1,..,N \,,$$

where $P_{Ai,t}$ is the price of good i in America at time t (in dollars), $P_{Bi,t}$ is the price of the same good in Britain at the same time (in pound sterling), and S_t is the nominal exchange rate of the US dollar (the price in pound sterling for purchasing one dollar).

Equation (3.1) imposes a restriction on the price levels of the same good in different countries. Instead, the relative version of the Law of One Price imposes a restriction on the changes in these price levels, more specifically:

(3.1') $$\frac{S_{t+1} \, P_{Ai,t+1}}{P_{Bi,t+1}} = \frac{S_t \, P_{Ai,t}}{P_{Bi,t}} \;, \quad i = 1,..,N$$

In essence, the relative version argues that the deviation, if any, between the prices of some good in the two countries in one time period also holds in the next period. The relative version of the Law of One Price is weaker than the absolute version, simply because equation (3.1) implies equation (3.1'), but not vice versa. That is, if there is a constant deviation from the Law of One Price, the relative version holds while the absolute version does not.

To get from the Law of One Price to Purchasing Power Parity (henceforth PPP), we have to go from the microeconomic to the macroeconomic level and look at price indices. Virtually all countries publish several types of price indices, such as the consumer price index, the producer price index, the GDP deflator, etc. All of these are constructed in different ways, emphasize different aspects of the economy and can be used for PPP comparisons, see also Box 3.2. The exposition below focuses on the consumer price index (CPI). The CPI is usually constructed as a weighted average of the prices of individual (groups of) products, with the weights representing the share of income spent by households on a particular product in some reference year. Let α_i be the weight of product *i* and let $P_{A,t}$ denote America's price index in period *t*, given by

$$(3.2) \quad P_{A,t} = \sum_{i=1}^{N} \alpha_i P_{Ai,t} \ , \quad with \quad \alpha_i \geq 0, \ \sum_{i=1}^{N} \alpha_i = 1$$

Now suppose that Britain's price index $P_{B,t}$ is constructed identically (this need not be the case, which is a potential cause for PPP deviations, see sections 3.4 and 3.5). If the absolute version of the Law of One Price (equation 3.1) holds for individual products, this means there is a clear relationship between the exchange rate and the price indices in Britain and America:

$$(3.3) \quad P_{B,t} = \sum_{i=1}^{N} \alpha_i P_{Bi,t} = \sum_{i=1}^{N} \alpha_i \left(S_t P_{Ai,t}\right) = S_t \sum_{i=1}^{N} \alpha_i P_{Ai,t} = S_t P_{A,t} \ ,$$

where the second term from the left is simply the definition of Britain's price index, the third term follows from the absolute Law of One Price for individual products, the fourth term takes the (common) exchange rate out of the summation sign, and the fifth term follows from the definition of America's price index. The first and last terms of equation

(3.3) can be more conveniently written in logarithmic form. As this is the case more generally in the monetary parts of this book, we henceforth agree to the following:

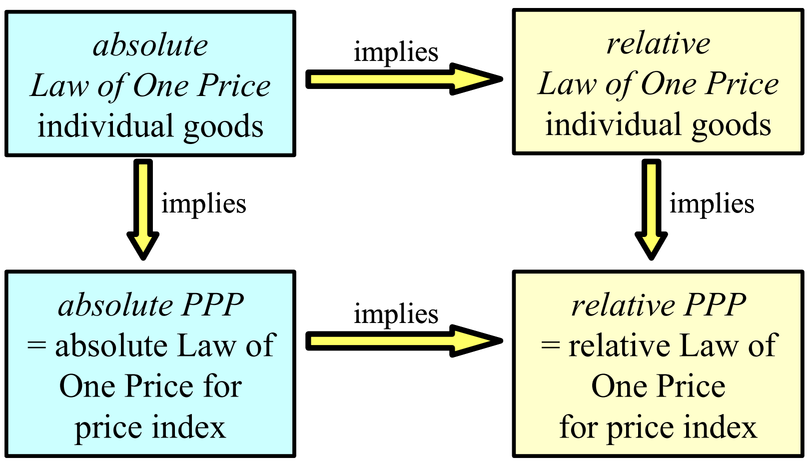
Convention: a lower case letter x of a variable X in general denotes its natural logarithm, that is $x = \ln(X)$. So, for example, $s_t = \ln(S_t)$, $p_{A,t} = \ln(P_{A,t})$, etc.

Using this convention, a slight re-arrangement of equation (3.3) gives us the absolute version of PPP in logarithmic terms, see equation (3.4). Writing the latter in time differences, gives us the relative version of PPP, see equation (3.4').

(3.4) $s_t = p_{B,t} - p_{A,t}$

(3.4') $(s_{t+1} - s_t) = (p_{B,t+1} - p_{B,t}) - (p_{A,t+1} - p_{A,t})$

*Figure 3.1 Different versions of the Law of One Price and PPP**



* Some qualifications for the implication arrows may apply, see the main text for details.

The relative version of PPP (eq. 3.4') can either be derived from the absolute version of PPP (eq. 3.4) or from the relative version of the Law of One Price (eq. 3.1').[11] Both of these can, in turn, be derived from the absolute version of the Law of One Price. Figure 3.1 schematically summarizes the strongness of these 'laws' and their relationships. The absolute version of the Law of One Price for individual goods is the strongest condition and, under some qualifications, implies all other versions without being implied by any of

[11] The latter is based on a similar argument as going from (3.1) to (3.4).

them. Similarly, the relative version of PPP is the weakest of all assumptions: it is implied by all other versions and does not imply any of them.

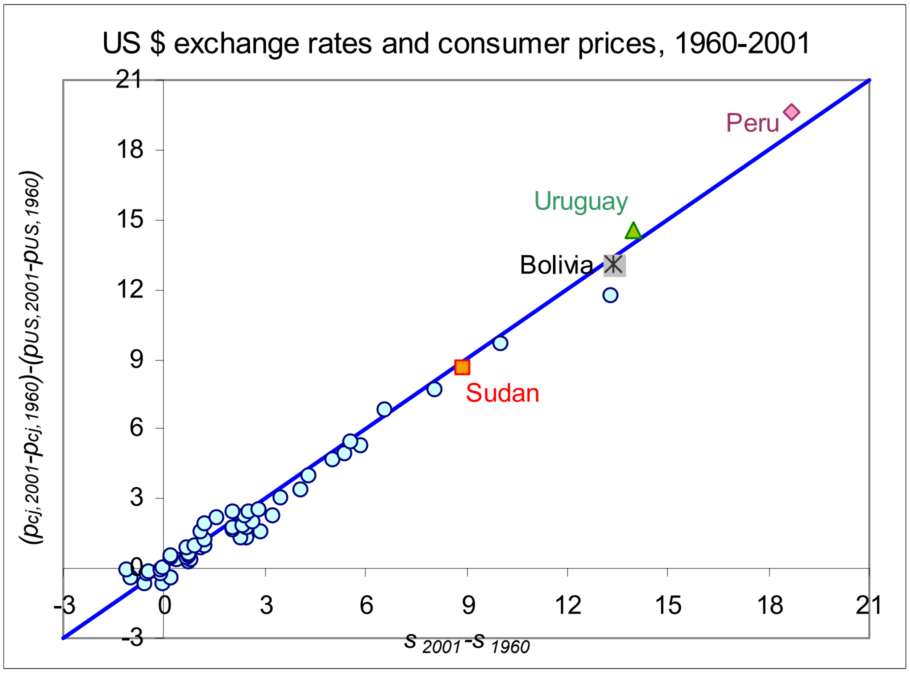
3.3 Prices and exchange rates

Is there an empirical relationship between exchange rates and price indices, as suggested by the PPP conditions in section 3.2? You bet! A very simple, but quite convincing, demonstration of this relationship is based on the (weakest) relative PPP version (eq. 3.4'), as illustrated in Figure 3.2. As we will argue below, the PPP relationship is actually a long-run relationship, with substantial deviations from PPP 'equilibrium' in the short-run. To find supporting evidence of relative PPP, we therefore have to look at a long enough time period to ensure that the deviations between developments in price indices in two different countries are big enough, and the associated economic arbitrage forces strong enough, to allow for these differences to have an impact on the exchange rate. Using World Bank data, we can analyze a time period of 41 years. At this stage, we are not interested in the details of the developments over time, just in the extremes, that is the first year of observation (1960) and the last year of observation (2001). We will use the United States as benchmark country. Under those circumstances, the (logarithmic) relative PPP equation (3.4') translates into:

(3.5) $$s_{2001} - s_{1960} = (p_{cj,2001} - p_{cj,1960}) - (p_{US,2001} - p_{US,1960}); \quad cj = 1,..,55 ,$$

where s is the US dollar exchange rate in foreign currency and p_{cj} is the consumer price index for the 55 countries for which both exchange rates and price indices were available. Figure 3.2 depicts the left-hand-side of equation (3.5) on the horizontal axis and the right-hand-side on the vertical axis for 55 data points. They are nearly all on a straight line through the origin with a 45° slope (also depicted in the figure), as would be predicted by equation (3.5), providing visual support for the relative PPP hypothesis. The largest deviations from the 45 degree line are some (mostly Latin American) countries at the upper-right hand of the diagram which have had very high inflation rates relative to the US and concomitant high increases in the US dollar exchange rate.

Figure 3.2 Exchange rates and prices, 1960-2001



Calculations based on World Bank CD-ROM, 2003; 55 observations; the line has a 45° slope; see the main text for details.

(3.5') $s_{2001} - s_{1960} = \underset{(0.0875)}{0.235} + \underset{(0.0174)}{0.993} \times [(p_{cj,2001} - p_{cj,1960}) - (p_{US,2001} - p_{US,1960})]$

Equation (3.5') reports the econometric estimate of equation (3.5) based on the empirical observations depicted in Figure 3.2. See Box 3.1 for an explanation of this procedure. The estimated standard errors are denoted in parentheses immediately below the estimated coefficients. The overall goodness-of-fit is quite good, as 98.4 per cent of the variance is explained by the regression ($R^2 = 0.984$). Some simple hypotheses tests would show that the estimated slope coefficient does not differ significantly from one (as would be implied by relative PPP theory) and that the estimated intercept is (just) significant (in contrast to this theory).[12] A more thorough discussion of these issues is deferred to section 3.6.

[12] As a clear outlier caused by its dollarization Ecuador was deleted from the data. This did not materially affect the analysis, although inclusion would have made the new estimated slope (0.195) insignificant.

Box 3.1 Basic econometrics and hypothesis testing

When we are developing different theories to try to better understand various economic phenomena, we often assume that the relationships between the economic variables we are analyzing are exact. In principle, our theories should lead to results, that is propositions or predictions that should hold empirically if the theory is true. If we gather economic data to test if the theoretical implications do indeed hold in reality, we need a method to determine if a theory is refuted or not. This is the work of econometricians. In practice, things are, as usual, not quite that simple for four main reasons.

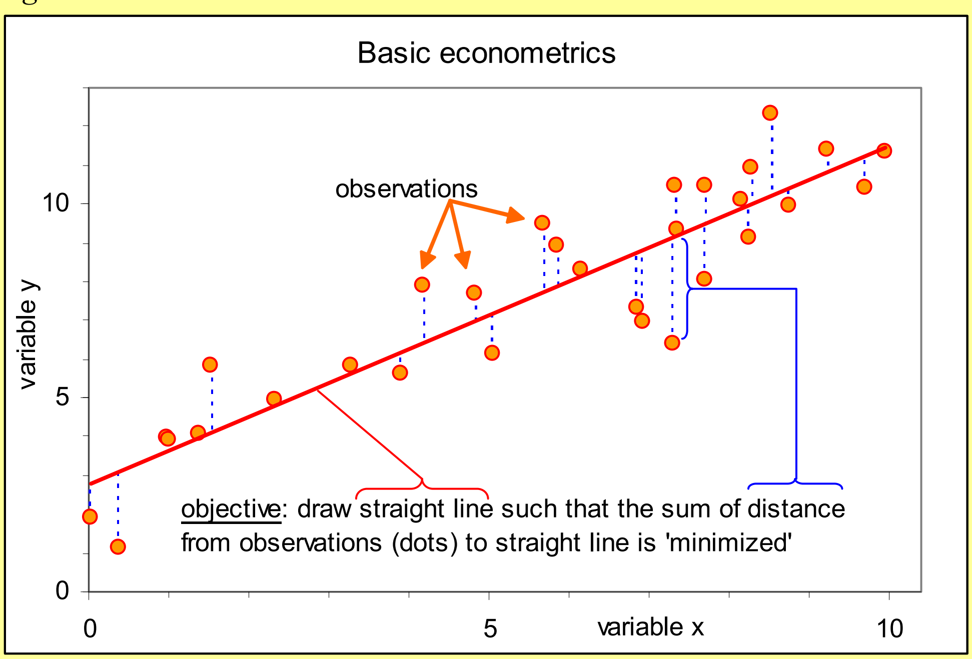
- First, we must recast the theory in a manner suitable for empirical evaluation and testing. This means we have to acknowledge the fact that the relationships between the economic variables of our theories are not exact due to simplifications and disturbances. There may, therefore, be deviations from the exact relationships which we can contribute to other phenomena, such as measurement errors or the weather, which do not immediately refute the theory. The point is, of course, that these deviations should not be 'too large'.
- Second, it can be very complicated, even after overcoming the first problem, to actually test the implications of a theory for technical or econometric reasons. Numerous examples can be given of the many hurdles econometricians sometimes have to take and traps to avoid, before they can devise an adequate test of what may at first look as a simple implication of a theory. Section 3.6 discusses some of these problems when testing for purchasing power parity.
- Third, it can be virtually impossible, even after overcoming the first and second problems, to pinpoint the nature of an observed friction between theory and empirics. Remember that our theories are usually based on a range of assumptions. In many cases, economic theorists may be convinced by the arguments of econometricians that an implication of a theory does not hold in practice, but disagree strongly on the particular assumption on which the theory was based which caused this friction. It can take several decades of scientific research, involving the development of new theories and new tests, etc., before some, if any, consensus on the nature of the problem is reached.
- Fourth, even if an empirical test confirms our theory, this does not necessarily prove it. Maybe some other theory can also explain the observations; we are never really sure.

The remainder of this box focuses on the simplest version of the first problem. Suppose we have an economic theory which predicts a linear relationship between the economic variables y and x: $y = a + bx$. Since all theories are simplifications of reality (which is what makes it theory), there is always a range of phenomena which might influence the actual relationship between the variables y and x. There can be other, more complicated, economic forces not modelled in the theory which could affect the relationship, there can be forces outside of economics (such as the weather, volcanic eruptions, or political changes) which could affect the relationship, there can be errors in measurement, etc. This leads us to posit that the observed relationship is as follows:

(3.7) $y_t = a + bx_t + u_t$,

where the sub index t denotes different observations (for example different time period or different countries) and the variable u_t denotes the deviation between the structural linear part of an observation and the actual value of the observation. This deviation should not be 'too large', so when we average it over many observations its value should be zero (it is, for example, normally distributed with mean 0 and variance σ^2).

Figure 3.3 Basic econometrics: observations and lines



An econometrician is, of course, not given the 'true' parameters *a* and *b* of the structural linear equation (although there may be 'implied' theoretical values, as discussed in this chapter). Instead, she is given a number of observations, that is joint pairs (x_t, y_t) of the economic variables *x* and *y*. These are depicted as the dots (or balls) in Figure 3.3. Her task is then to find the best line to fit these empirical observations, that is estimate an intercept, say $\bar{a}$, and a slope, say $\bar{b}$, to minimize the (quadratic) distance from the observations to the line. We are not concerned with how this is done here. Instead, we briefly discuss how hypotheses can be tested using this procedure.

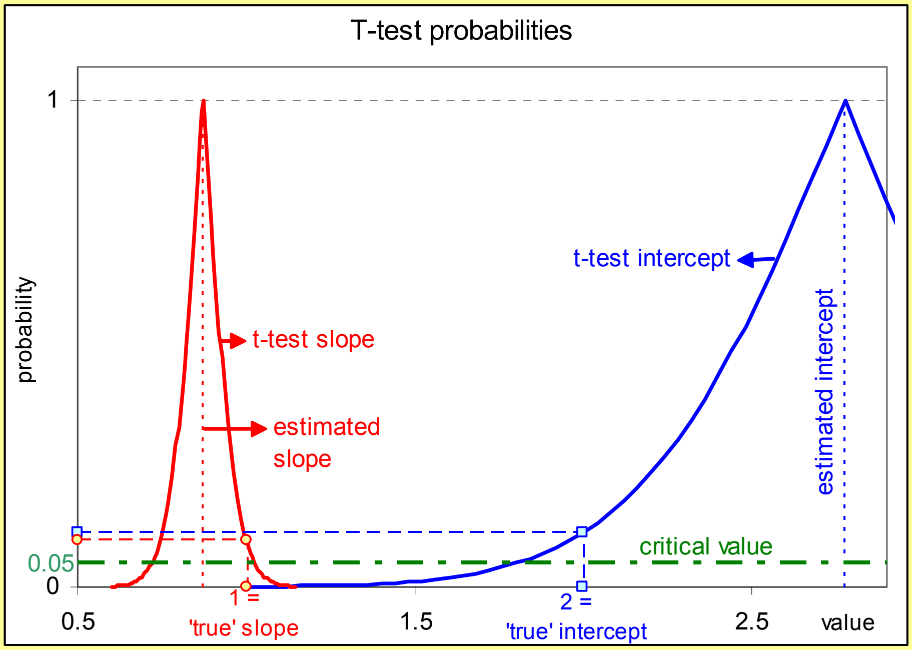
Figure 3.3 was artificially constructed based on a 'true' model with intercept 2 and slope 1 ($a = 2, b = 1$) by adding (normally distributed) disturbances u_t using a random number generator. Since the econometrician is only given the observations and not the true parameters, she tries to estimate these ($\bar{a}$ and $\bar{b}$) based on the observations. The terminology is to 'run a *regression*', where *y* is the *endogenous* variable (the variable to be explained) and *x* is the *exogenous* variable (the explanatory variable). She finds:

(3.8) $$y = \underset{(0.4730)}{2.776} + \underset{(0.0744)}{0.872} \cdot x$$

The numbers in parentheses in equation (3.8) are estimated standard errors of the estimated coefficients, see below. Instead of the true parameter 2 the econometrician therefore estimates the intercept to be 2.776 and instead of the true parameter 1 she estimates the slope to be 0.872. Well, we do not expect her to find the exact parameters, but how far off is she, is this within acceptable limits, and how good is the 'fit' of the estimated line? To start with the latter, it is clear that the fit is better the closer the observations are to the estimated line. A popular measure for this fit is the share of the variance of the variable *y* explained by the estimated line, the so-called R^2. In this case, 83.1 per cent of the variance is explained by the regression ($R^2 = 0.831$). In general, the higher R^2 the better the fit. It should be noted, however, that the share of the variance that can be explained differs widely per application, with some areas of economics where researchers are happy if they can explain 20 per cent of the variance and others where less than 90 per cent is considered bad. In this respect, the standard errors reported in equation (3.8) are more useful as they indicate the reliability of the estimated coefficients.

They can be used for hypothesis testing. Based on the so-called *t*-distribution, we can calculate the probability that the true parameter has a particular value, given the observations on the pairs (x_t, y_t) available to us and the associated regression line, see Figure 3.4.

*Figure 3.4 Hypotheses and critical values**



* There are 30 observations - 2 parameters estimated = 28 degrees of freedom for this t-test.

Suppose the theoretical model suggests that the slope should be equal to 1 (which is actually the true parameter, given the construction of the observations). Based on the available observations, the econometrician has estimated a slope of 0.872. Does this mean that the model is refuted? Not necessarily. As a result of the disturbances u_t, the estimated slope coefficient is associated with a degree of uncertainty. The *t*-test translates this uncertainty into a probability that the true parameter is equal to some value, for example the hypothesized value of 1, given the observations and estimated coefficients. If this probability is below some *critical* value (usually 5 per cent), the outcome is considered so unlikely that the hypothesis is rejected. In this case, the (two-sided) probability that the slope coefficient is 1 (or more) is equal to 9.64 per cent. This probability is higher than the critical value of 5 per cent, so the hypothesis is accepted and the theoretical model is not refuted. Other hypotheses can be tested similarly. For example, the hypothesis that the slope or the intercept of the regression is equal to zero is rejected (see Figure 3.4); we say the estimated coefficients are *significant*. The hypothesis that the intercept is equal to 2 is accepted, etc. As a rule-of-thumb: hypotheses within two standard deviations away from the estimated coefficient are accepted (in this case: slope in between 0.7232 and 1.0208 and intercept in between 1.830 and 3.722).

3.4 Real effective exchange rates

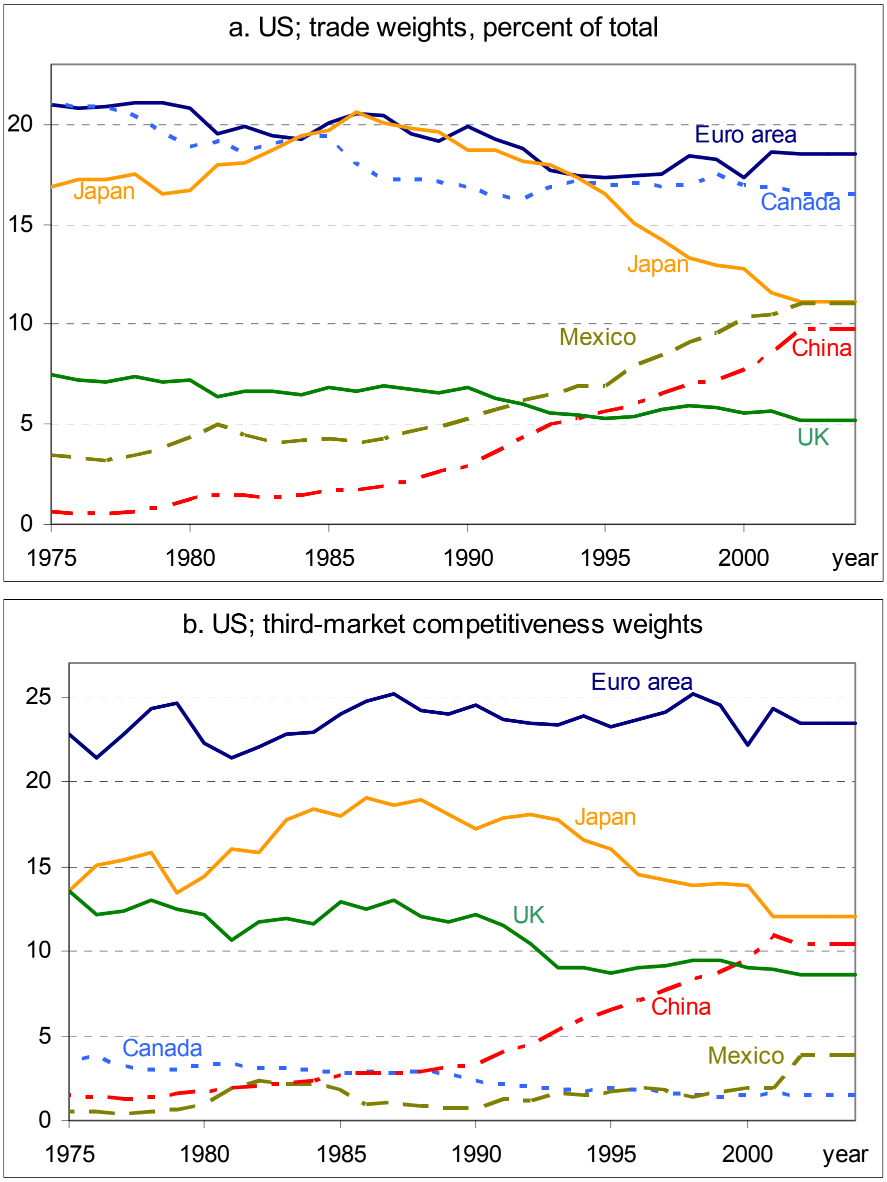
Section 3.2 derived the nominal exchange rate between two countries consistent with absolute or relative PPP, see equations (3.4) and (3.4'). On that basis, we can now define (in logarithmic terms) the *real* (bilateral) exchange rate, say q_t, as the difference between the nominal effective exchange rate and the price indices of the two countries:

(3.6) $q_t \equiv s_t - (p_{B,t} - p_{A,t})$.

This real exchange rate then provides a measure of the deviation from PPP between the two countries. We can, of course, also calculate the relative counterpart of the bilateral real exchange rate by taking the first difference of equation (3.6). In both cases, developments in the nominal exchange rate are corrected for developments in the price levels of the two countries, implying that the real exchange rate is a measure of the evolution of one country's competitiveness relative to another country. More specifically, if the real exchange rate in equation (3.6) increases, this implies that the higher price of the US dollar (s_t) is only partially offset by differences in price developments between Britain and America ($p_{B,t} - p_{A,t}$), so that America has become less competitive compared to Britain.

In practice, countries are more interested in the general development of their competitive position, not just relative to one country in particular. The *real effective exchange rate* does just that, by calculating a weighted average of the bilateral real exchange rates (see also section 20.5). It plays an important role in policy analysis as an indicator of the competitiveness of domestic relative to foreign goods and the demand for domestic and foreign currency assets. As the real effective exchange rate is an index, the focus is on changes of the index relative to some base year, that is the policy focus is on relative and not absolute PPP. The Federal Reserve has changed its weighing procedure from the earlier used share of total trade to a third-market competitiveness index, based on the share of a foreign country's goods in all markets that are important to US producers (see Box 3.2 for the ECB's method in this respect). Figure 3.5 illustrates the difference between these two procedures for the six largest trading partners of the US. Note that for the competitiveness index: (i) the developments tend to be more stable over time (see e.g. Japan), (ii) the importance of neighbouring states (Canada and Mexico) is reduced as is (to a smaller extent) the importance of Japan, and (iii) the importance of Europe is increased. The developments for China are similar using either trade weights or competitiveness weights, rising from less than 2 per cent in 1980 to about 10 per cent in 2004.

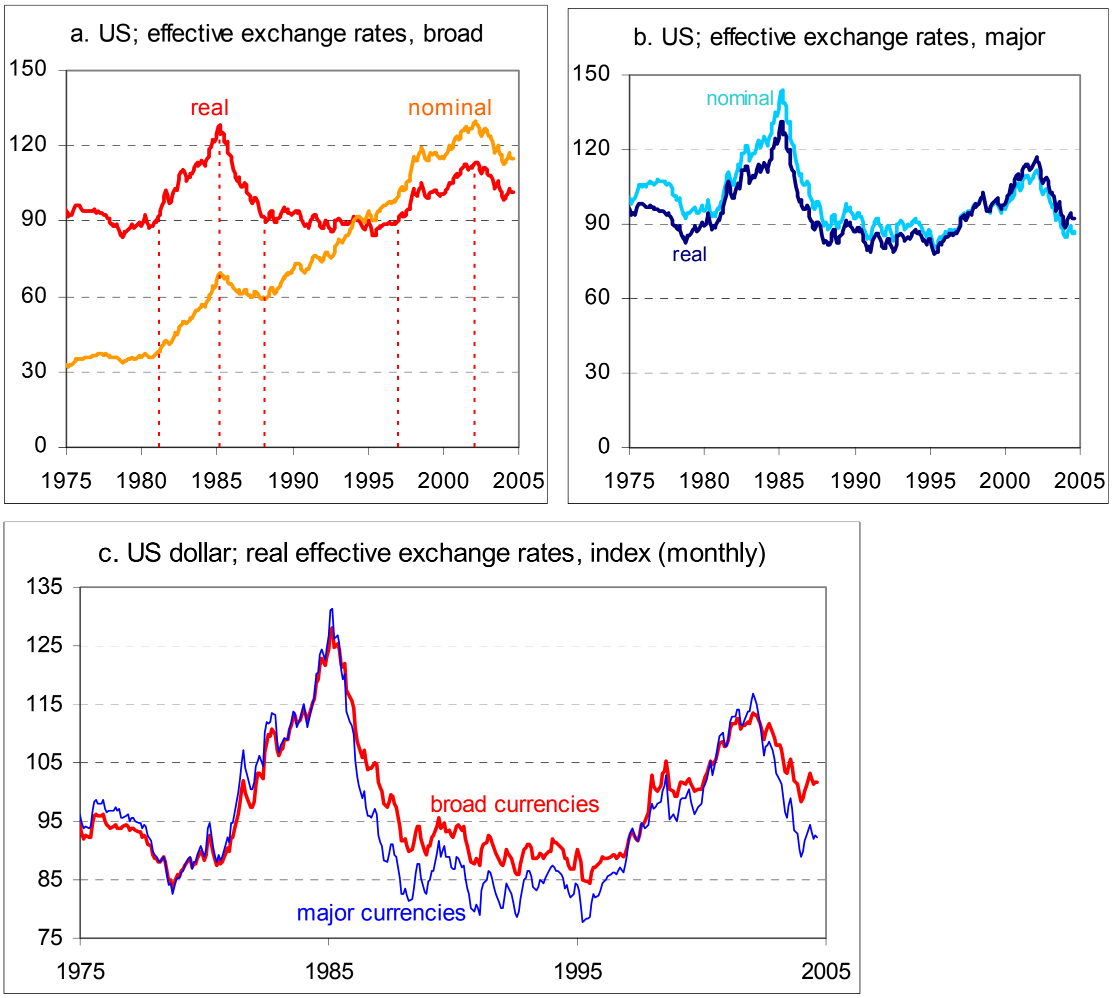
Figure 3.5 US dollar: trade weights (top six) and competitiveness weights



Data source: www.federalreserve.gov

Figure 3.6 shows the evolution of the real and nominal effective exchange rates for the US in the period 1975 – September 2004. As panel *a* makes clear, there is a big difference in the development of the real versus the nominal effective exchange rates for the broad range of currencies. There is, in particular, no consistent increase in the real value of the US dollar. The developments for the nominal and real exchange rates using the major foreign currencies as a benchmark are much more similar, see panel *b*. As already explained in section 20.5, this difference is caused by the inclusion of high-inflation countries in the broad index, compared to the absence of such countries in the major index. As panel *c* illustrates, there is little deviation in the developments of the real index for the major and broad index.

Figure 3.6 US dollar: real effective exchange rates



Data source: www.federalreserve.gov; see Chapter 2 for 'major' and 'broad' index.

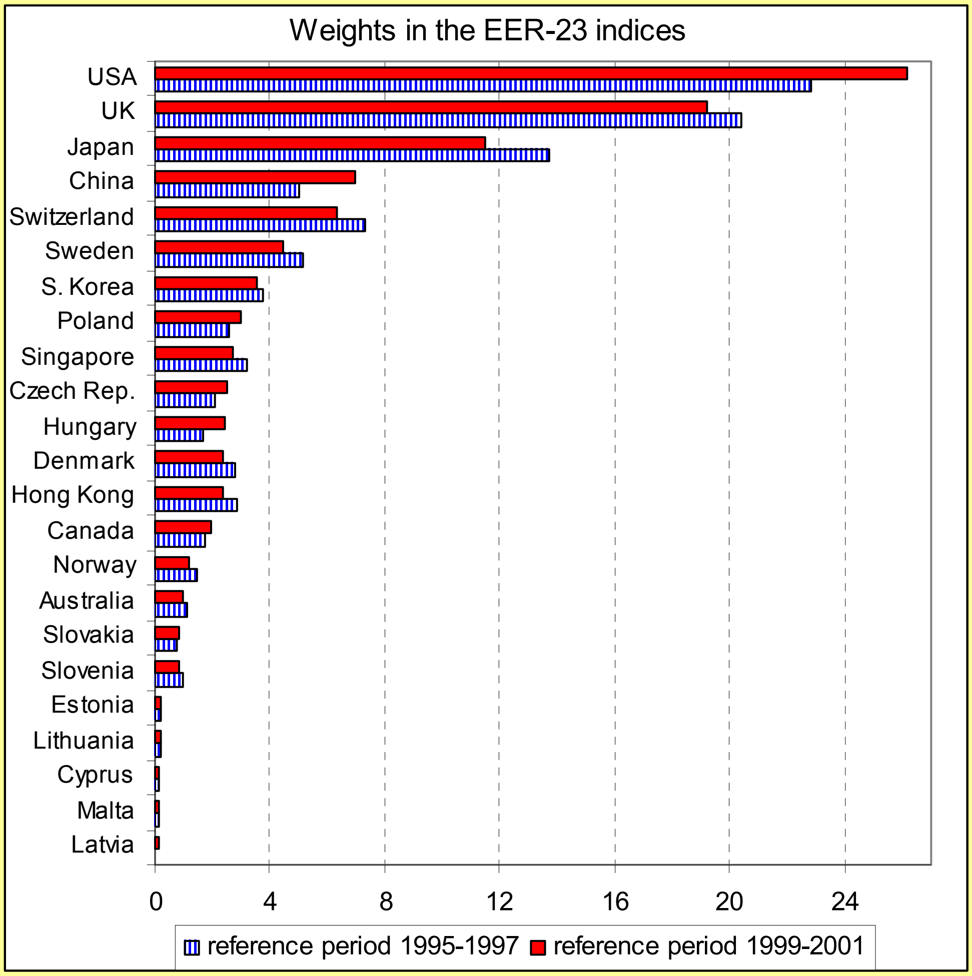
Can we deduce from Figure 3.6 whether or not PPP holds empirically? Well, yes and no. Ignoring changes in the underlying weights, if relative PPP were to hold for every time period and for all countries, the real effective exchange rate would have to be a horizontal line. If absolute PPP holds, the level of this line would be determined. Taking the broad index in panel *a* as our point of reference, the US real effective exchange rate clearly is not a horizontal line. Relative PPP therefore does not hold for all time periods. There is, however, not a consistent upward or downward movement. Instead, compared to a baseline of roughly 90 points, there are two large upward deviations (as indicated in panel *a*), namely in the period 1981-1988 (with a peak in March 1985) and in the period 1997-2004 (with a peak in February 2002). Both these periods and their relationships with economic policy will be discussed in forthcoming chapters. For now, it suffices to note that on the basis of the US experience, short-run relative PPP does not hold. Indeed, there can be large and prolonged deviations from short-run PPP. However, we do not see a consistent upward or downward movement. Instead, relative PPP tends to return to some base level. This suggests that in the long-run relative PPP does hold. A formal analysis to substantiate this claim is beyond the scope of this book, but section 3.6 provides a discussion of empirical literature which substantiates this claim.

Box 3.2 Effective exchange rates of the euro

Like the Federal Reserve, the European Central Bank (ECB) regularly publishes effective exchange rates, namely both real and nominal effective index rates of the euro (1999-Q1 = 100) relative to two groups of countries (EER 23 = a benchmark group of 23 countries; EER-42 = a broader group of 42 countries).[13] The September 2004 issue of the ECB's Monthly Bulletin introduced this new set of effective exchange rates, following an update of the associated trade weights and an extension of the list of the euro area's trading partners. The weights are based on exports and imports (excluding intra-euro area trade), where the exports are double-weighted to capture the competition faced by euro area exporters in foreign markets (third-market effects), see Figure 3.7.

Figure 3.7 Euro: effective index weights, EER-23

[13] The ECB calculates no less than five real rates, using as deflators: consumer price indices (CPI), producer price indices (PPI), gross domestic product (GDP deflator), unit labour costs in manufacturing (ULCM) and unit labour costs in the total economy (ULCT).

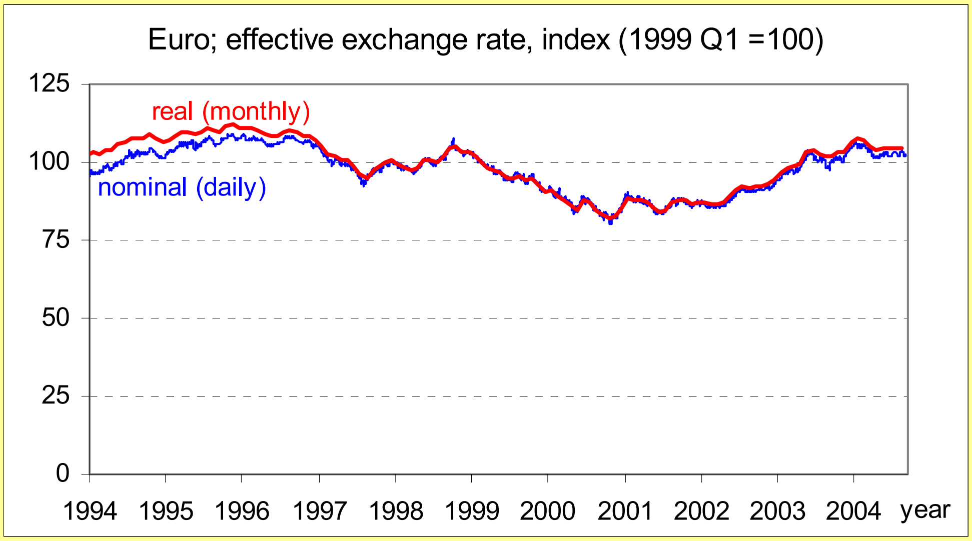


Data source: ECB (2004, Box 10).

Figure 3.8 depicts the evolution of the real and nominal effective exchange rates of the euro since 1994. Obviously, euro data were not available prior to the formation of the euro, so in that period the data are based on a basket of euro legacy currencies.[14] Perhaps in view of the more limited time period, the value of the euro has not fluctuated as substantially (nor as abruptly) as the value of the US dollar. In addition, and similar to the major index of the US, the deviation between the nominal and real index rate is relatively small. Again similar to the US, the deviation between the nominal and real index is more substantial for the broader group of EER-42 countries. This is not shown in the diagram, see however ECB (2004, box 10).

[14] The euro area is assumed fixed for the whole period, so it includes Greece throughout the period even though Greece only joined on 1 January 2001.

Figure 3.8 Euro: nominal and real effective exchange rates



Data source: www.ecb.int ; real rate is based on CPI, EER-23

3.5 Causes of deviations from PPP

Section 3.4 has shown that there can be substantial and prolonged periods of deviation from relative PPP exchange rates. To understand some of the potential causes for these deviations, it is most fruitful to take a closer look at the more important of the many assumptions we had to make before we could invoke the Law of One Price for individual goods on which PPP is based, see section 3.2.

Transaction costs. An obvious reason for a failure of the Law of One Price is the existence of transaction costs, including shipping costs, insurance costs, tariffs and non-tariff barriers, etc. Any such transaction costs will impose a band width around the Law of One Price rates within which arbitrage is not profitable. Only substantial deviations of the exchange rate enable agents to benefit from arbitrage opportunities. Acknowledging that the band width will vary from one good to another, this suggest that the arbitrage forces will gradually become stronger as the deviation of the exchange rate from PPP increases. One measure for the extent of these types of transaction costs is the deviation between cost, insurance, and freight (CIF) and free on board (FOB) quotations of trade, see Box 14.1 for a further discussion.

Differentiated goods. In deriving the Law of One Price, we assumed we were dealing with homogenous goods. In practice, very few goods are perfectly homogenous. Wines differ not only from one country to another, but even per region and vineyard, a Toyota differs from a Mercedes, there are many different varieties of tulips, etc. In fact, the more knowledgeable you are about specific commodities, the better you usually realize that these are differentiated products, even for such basic items as types of flour, qualities of oil, or grades of iron ore. Since we lump all these different goods together under one heading when constructing our price indices, it is no surprise that absolute PPP does not hold, nor that there can be prolonged deviations of relative PPP. Nonetheless, the various types of differentiated goods are to some extent substitutes for one another. Again, this implies that the arbitrage forces will gradually become stronger as the deviation of the exchange rate from PPP increases.

Fixed investments and thresholds. Before one can take advantage of arbitrage opportunities, economic agents usually have to incur a fixed investment cost to do so, such as establishing reliable contacts, organize shipping and handling, have a distribution and service network, etc. Based on earlier work of the theory of investment under uncertainty, Dixit (1989) and Dumas (1992) therefore argue that in addition to the transaction costs imposing a band width, the sunk cost of investment associated with engaging in arbitrage ensures that traders wait until sufficiently large opportunities open up before entering the market. As Sarno and Taylor (2002, p. 56) put it: “Intuitively, arbitrage will be heavy once it is profitable enough to outweigh the initial fixed cost, but will stop short of returning the real rate to the PPP level because of the .. arbitrage (CvM: i.e. transaction) costs.” Since the investment costs will vary for different types of goods, this yet again implies that the arbitrage forces will gradually become stronger as the deviation of the exchange rate from PPP increases.

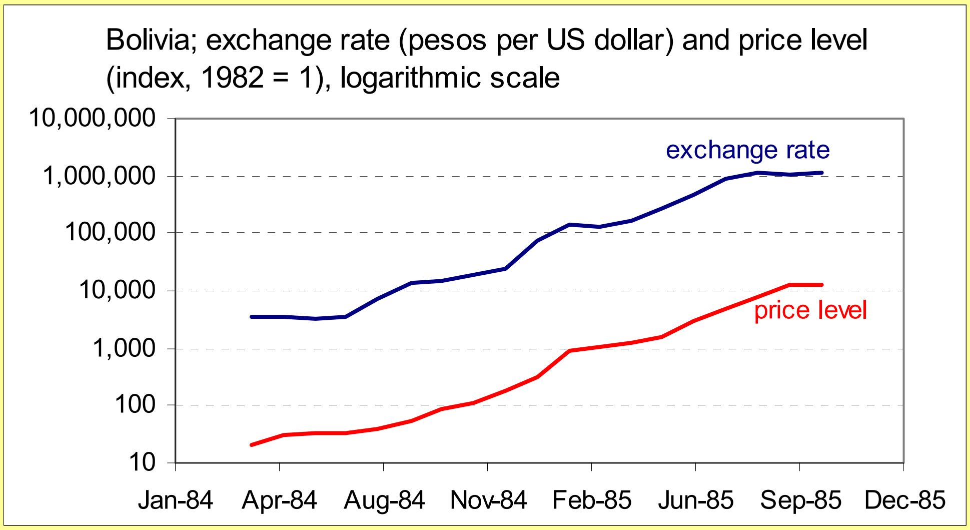
Non-traded goods. When invoking the Law of One Price to derive PPP, we implicitly assumed that all goods entering the construction of the price index were tradable. In fact, a large share of our income, perhaps as much as 60-70 per cent, is spent on non-tradable goods, that is on products or (more frequently) services that effectively cannot be traded between countries and for which arbitrage, which drives PPP, is not possible. Important examples are housing services, recreational activities, health care services, etc. Although one could argue that the existence of non-tradable goods is just an extreme (namely infinite) case of transaction costs, there is a long tradition in international economics to devote special attention to the distinction between tradable and non-tradable goods, and for good reasons. These issues, and the degree to which non-tradable goods introduce a bias in PPP deviations, are therefore discussed separately in section 3.7 below.

Composition issues. Related to the above point is the observation that in deriving the PPP exchange rate in section 3.2, we assumed that the price indices in the two countries are constructed in an identical way. In practice, this is not the case. Not only do the weights for different categories differ per country, but also the types of goods associated with each category. Obviously, these construction differences can cause deviations from PPP, even when the absolute Law of One Price holds for every individual good. When dealing with many countries, as is the case when we calculate real effective exchange rates, these problems are exacerbated.

Box 3.3 Exchange rates, and prices under hyperinflation

The case of Bolivian hyperinflation in 1984 and 1985 already discussed in Box 19.3 also provides a good test for the validity of PPP under extreme circumstances. The monthly Bolivian inflation rate peaked at 183 per cent (from January to February in 1985). At the same time, the exchange rate of foreign currencies measured in Bolivian pesos (the price of foreign currencies) increased very rapidly. The monthly increase in the price of the US dollar, for example, peaked at 198 per cent (from December 1984 to January 1985). Obviously, with such high inflation rates, which dwarf the importance of the foreign inflation rates (in this case in the USA), we expect (on the basis of PPP) that changes in the exchange rate are dominated by changes in the Bolivian price level, see equation (3.4). In fact, this is what happened: from April 1984 to July 1985, Bolivian prices increased 230-fold, while in that same period, the US dollar exchange rate increased 247-fold. Figure 3.9 uses a logarithmic graph of the exchange rate and the price level in this period to illustrate this. The slope of the price level curve therefore represent the inflation rate and the slope of the exchange rate curve the growth rate of the price increase of the US dollar. The similarities in the two curves, and therefore the suggested validity of long-run PPP, are obvious. See Box 19.3 for further details. Moreover, see Figure 3.2 for Bolivia's performance on exchange rates and prices in the period 1960-2001.

Figure 3.9 Exchange and prices under extreme circumstances



Calculations based on Morales (1988, Table 7A1).

3.6 Testing for PPP

There have been many empirical tests of PPP in the last four decades and an enormous evolution of the proper underlying procedures for these tests. This section gives a brief overview of the empirical findings, see Sarno and Taylor (2002, ch. 3) for an excellent and more detailed review. Early empirical tests of PPP (until the late 1970s) were essentially directly based on equation (3.4). More specifically, one would estimate the equation (see Box 3.1 for some econometrics and testing basics):

(3.7) $s_t = \gamma_1 + \gamma_2 p_{at} + \gamma_3 p_{bt} + u_t$

A test of the hypothesis: $\gamma_2 = 1, \gamma_3 = -1$ would be interpreted as a test of absolute PPP. Using this test for first differences in equation (3.7), that is replace s_t by $s_{t+1} - s_t$, etc., would be interpreted as a test of relative PPP. In general, this early literature, which did not use dynamics to distinguish between short-run and long-run effects, rejected the PPP hypothesis. A clear exception is the influential study by Frenkel (1978), who analyzes high inflation countries and gets parameter estimates very close to the PPP values, suggesting that PPP holds in the long-run.

As it turns out, there are many econometric problems associated with the early testing procedure. An economic issue is the so called endogeneity problem, referring to the fact that in equation (3.7) it is not simply prices determining exchange rates, but both prices and exchange rates are determined simultaneously in a larger economic system.[15] The most important problem is, however, purely technical (that is: econometric) in nature, in that the early literature did not properly investigate the residuals of the estimated equation to verify the stochastic properties on which the estimates, and hence the associated PPP tests, are based. See Granger and Newbold (1974) and Engle and Granger (1987) for these spurious regressions and so called cointegration and stationarity problems.

The early studies of these second generation tests addressing the econometric problems of PPP testing were rather mixed in their support for PPP, see for example Taylor (1988) and Taylor and McMahon (1988). Once it was realized that these early cointegration studies, which tended to focus on rather short time periods, had very low power of the tests, that is low precision with which definite conclusions can be drawn, it was clear that one final econometric problem had to be overcome. Two methods were devised to address this power problem, namely analyzing really long time series data and analyzing panel data. Both methods generally support long-run (relative) PPP. As the name suggests, the really long time series method extends the period of observation, which introduces an exchange rate regime-switching problem (from gold standard to Bretton Woods to floating exchange rates, see Chapter 5). Frankel (1986) analyzes dollar – sterling data from 1869 to 1984. See also Edison (1987), Glen (1992), and Cheung and Lai (1994). Panel data studies avoid the regime-switching problem by focusing on a short time period of analysis (usually the more recent floating exchange rates), but combine evidence from many different countries simultaneously in one test. The most powerful

[15] Krugman (1978) constructs a simple model to address this endogeneity problem in which the monetary authorities intervene against real shocks with monetary policies, thus influencing both exchange rates and prices. His parameter estimates are indeed closer to the PPP hypothesis.

test used in Taylor and Sarno (1998), for example, provides evidence supporting long-run PPP during the recent float period.

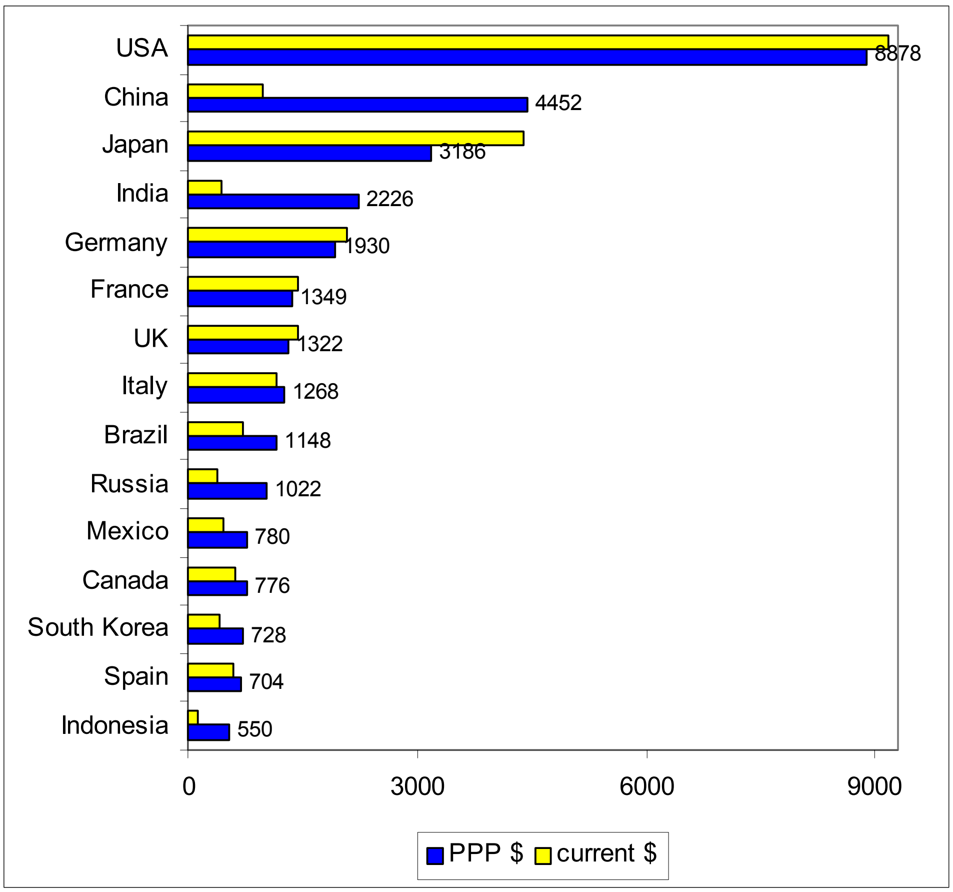
3.7 Structural deviations: PPP corrections

The above discussion focused on the empirical validity of *relative* long-run PPP. A frequently reported, in principal quite different but nonetheless related problem, is the phenomenon of *PPP corrections*. The correction problem focuses on the fact that there is a consistent bias in real income measures for different countries when the nominal exchange rate is used as a basis for comparison. As such it argues that there is a consistent bias in *absolute* PPP deviations. As mentioned in section 3.5, the argument is based on the distinction between traded and non-traded goods. It goes back to Harrod (1933), Balassa (1964), and Samuelson (1964), and is therefore known as the *Harrod-Balassa-Samuelson effect*.

The ranking of production value using current US dollars, that is converted at the going exchange rate, is deceptive because it tends to overestimate production in the high-income countries relative to the low-income countries. To understand this we have to distinguish between *tradeable* and *non-tradeable* goods and services. As the name suggests, tradeable goods and services can be transported or provided in another country, perhaps with some difficulty and at some costs. In principle, therefore, the providers of tradeable goods in different countries compete with one another fairly directly, implying that the prices of such goods are related and can be compared effectively on the basis of observed (average) exchange rates. In contrast, non-tradeable goods and services have to be provided locally and do not compete with international providers. Think, for example, of housing services, getting a haircut, or going to the cinema.

Since (i) different sectors in the same country compete for the same labourers, such that (ii) the wage rate in an economy reflects the average productivity of a nation, and (iii) productivity differences between nations in the non-tradeable sectors tend to be smaller than in the tradeable sectors, converting the value of output in the non-tradeable sectors on the basis of observed exchange rates tends to underestimate the value of production in these sectors for the low-income countries. See Box 3.4 for details. For example, on the basis of observed exchange rates, getting a haircut in the USA may cost you $10 rather than the $1 you pay in Tanzania, while going to the cinema in Sweden may cost you $8 rather than the $2 you pay in Jakarta, Indonesia. In these examples the value of production in the high-income countries relative to the low-income countries is over-estimated by a factor of 10 and 4, respectively.

Figure 3.10 Gross national product; ranked according to PPP, 1999



To correct for these differences, the United Nations International Comparison Project (ICP) collects data on the prices of goods and services for virtually all countries in the world and calculates ‘purchasing power parity’ (PPP) exchange rates, which better reflect the value of goods and services that can be purchased in a country for a given amount of dollars. Reporting PPP GNP levels therefore gives a better estimate of the actual value of production in a country.

Figure 3.10 illustrates the impact on the estimated value of production after correction for purchasing power by comparing it to the equivalent value in current dollars. The USA is still the largest economy, but now 'only' produces 3.6 per cent of world output, rather than 30 per cent. The estimated value of production for the low-income countries is much higher than before. The relative production of China (ranked second) is more than three times as high as before (rising from 3.2 per cent to 10.8 per cent), similarly for India (rising from 1.4 per cent to 5.4 per cent), Russia (rising from 1.2 per cent to 2.5 per cent), and Indonesia (rising from 0.4 per cent to 1.3 per cent).[16] The drop in the estimated value of output is particularly large for Japan (falling from 14.3 per cent to 7.8 per cent), reflecting the high costs of living in Japan. Of course, when estimating the importance of an economy for world trade or capital flows, it is more appropriate to use the actual exchange rates on which these transactions are based, rather than PPP exchange rates.

Box 3.4 Purchasing power parity (PPP) corrections

Suppose there are two countries (Australia and Botswana) each producing two types of goods (traded goods and non-traded goods) using only labour as an input in the production process. This box is based on the Ricardian model, see Chapter 3. All labourers are equally productive within a country (homogenous labour and constant returns to scale), but there are differences in productivity between countries. As illustrated in Table 3.1, we assume Australian workers to be five times more productive in the traded goods sector and only twice as productive in the non-traded goods sector.

Table 3.1 Labor productivity in Australia and Botswana

	Number of products produced per working day	
	Traded goods	Non-traded goods
Australia	20	20
Botswana	4	10

[16] These per centages are not listed in Figure 3.10. More details are provided on the book's website.

- Between country arbitrage; assuming there are no transport costs or other trade restrictions, arbitrage in the traded goods sector will ensure that the wage rate in Australia will be five times as high as the wage rate in Botswana because Australian workers are five times more productive. Taking this as the basis for international income comparisons leads us to think that per capita income is 400 per cent higher in Australia than it is in Botswana.
- Within country arbitrage; assuming labor mobility between sectors within a country, arbitrage for labor between the traded and non-traded goods sector will ensure that the price of traded goods in local currency is the same as the price of non-traded goods in Australia (because labor is equally productive in the two sectors), whereas the price of traded goods in local currency is 2.5 times as high as the price of non-traded goods in Botswana (because labor is 2.5 times less productive in the traded goods sector than in the non-traded goods sector). In local currency, therefore, non-traded goods are much cheaper compared to traded goods in Botswana than in Australia.
- Real income comparison; suppose that 40 per cent of income is spent on non-traded goods in both countries. Some calculations (based on a Cobb-Douglas utility function) then show that the real per capita income is 247 per cent higher in Australia than in Botswana. Although substantial, this is significantly lower than our earlier estimate of 400 per cent because non-traded goods are relatively much cheaper in Botswana than in Australia. The 153 per cent (= 400 per cent – 247 per cent) overestimated difference between income in current $ and real income is larger, (i) the larger the share of income spent on non-traded goods, and (ii) the larger the international deviation between productivity in traded compared to non-traded goods.

3.8 Conclusions

If there are no impediments whatsoever to international arbitrage, an identical good should sell for the same price in two different countries at the same time. This absolute version of the Law of One Price for individual goods can be used to derive a relative version of the Law of One Price (focusing on changes rather than levels) and a (relative and absolute) version relating exchange rates and price indices, referred to as purchasing power parity (PPP). The derivation is based on assumptions which, if they do not hold exactly, can cause deviations from PPP. The most important causes of such deviations are transaction costs, composition issues (the way in which indices are constructed), and the existence of differentiated goods, fixed investments, thresholds, and non-traded goods. Empirical studies do, indeed, find substantial and prolonged short-run deviations from relative PPP as measured by real effective exchange rates. In the long-run, however, relative PPP holds remarkably well, certainly in view of the strict assumptions necessary for deriving PPP. The majority of the remaining chapters will focus on structural models invoking long-run (relative) PPP. There is, therefore, a bias in our analysis to try to understand the long-run equilibrium implications of economic policies and developments. It should be noted, finally, that there is a structural bias in deviations from absolute PPP based on observed differences between countries of traded relative to non-traded goods. This so called Harrod-Balassa-Samuelson effect makes PPP corrections necessary when comparing, for example, the real income levels of different countries. Such corrections are now widely available.

Chapter 4 Interest rate parity

Objectives / key terms

nominal and real interest rates	Fisher equation
inflation and deflation	maturity
term structure of interest rates	rising, flat, and falling term structure
perfect substitutes	covered interest parity
uncovered interest parity	risk neutrality
rational expectations	market efficiency
simple efficiency hypothesis	exposure (translation, transaction, economic)
risk aversion	risk premium

After discussing nominal and real interest rates and the term structure of interest rates, we derive the covered and uncovered interest parity conditions, relating differences in international interest rates with the forward exchange market premium and the expected rate of appreciation, respectively. As these conditions are crucial for understanding the foreign exchange markets, we evaluate them empirically in conjunction with risk premia.

4.1 Introduction

Chapter 3 established a clear, long-run relationship between exchange rates and price levels known as purchasing power parity. In this chapter we will establish a clear short-run and medium-run relationship between exchange rates and interest rates. Obviously, this ensures that exchange rates, interest rates, and prices are all inter-connected and determined simultaneously within the economic system. Such systems are analyzed in parts *E* and *F* of this book. The driving force behind the links between interest rates and the foreign exchange markets is arbitrage. We have already seen in Chapter 2 that arbitrage is a powerful force on the foreign exchange market for ensuring that the same currency is traded at the same price in different locations at the same time. Here, we will focus on arbitrage relating markets in different time periods. Depending on the type of arbitrage (either hedged or unhedged) we derive two important relationships between interest rates and exchange rates, both of which will be evaluated empirically. First, however, we take a closer look at the structure of interest rates.

4.2 Interest rates

In addition to the more indirect, long-run link between interest rates and prices through the exchange rate discussed in the introduction to this chapter, there is also a direct link between interest rates and the price level. When you invest some money, say € 1 million, for some time period in a euro zone country, such as the Netherlands, the *nominal* interest rate, which we will denote by the letter i, represents the reward to you in terms of euros. However, as a consumer you are not interested in this nominal value, but in the real goods and services you can purchase with these funds. To calculate the real return to your investment, that is the *real* interest rate which we will denote by the letter r, you will have to correct your nominal return for increases in the price level. If we let the greek letter π denote the inflation rate in the economy, we can simply do this by using the (Irving) *Fisher equation*:

(4.1) $r = i - \pi$

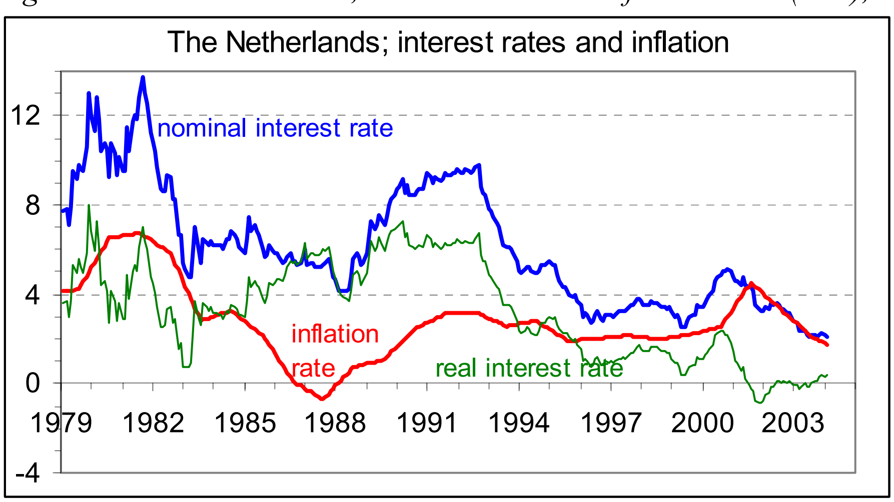
As a reminder, we will use the following notation in the sequel:

i = nominal interest rate

π = inflation rate

r = real interest rate

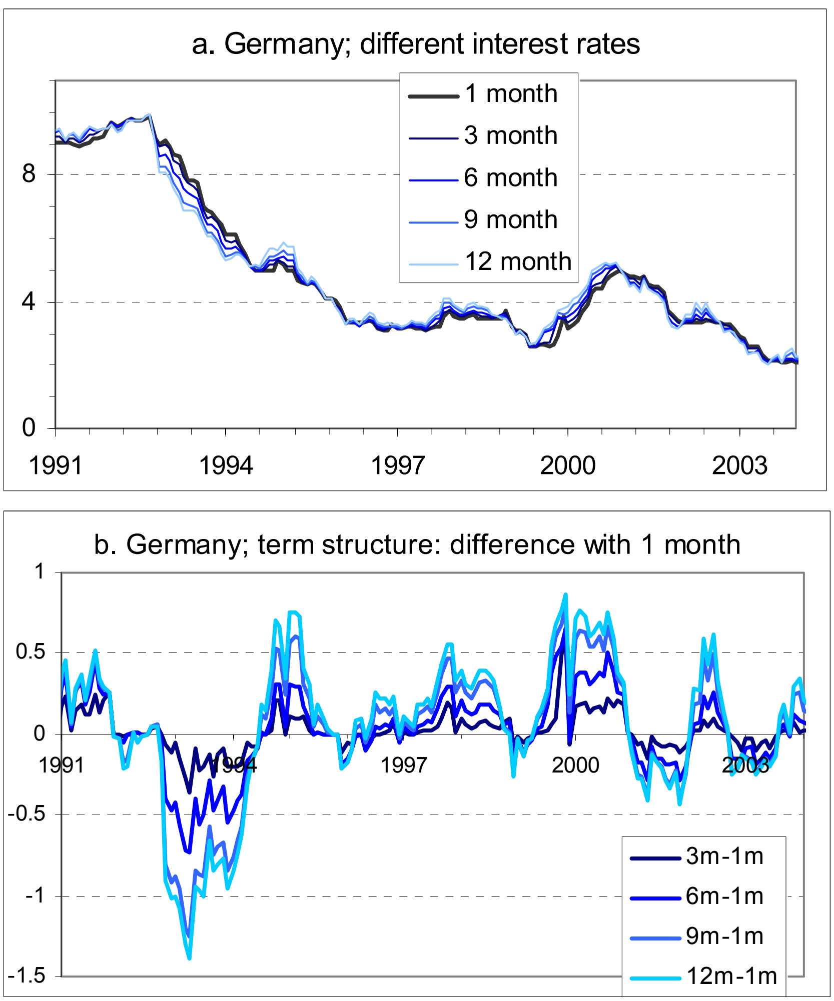
Figure 4.1 The Netherlands; interest rates and inflation rates (CPI), 1979 – 2004



Data sources: IFS (interest rate, 6 month interbank middle rate), World Bank Development Indicators CD-ROM (inflation 1960-2001), and Dutch Central Bureau of Statistics (www.cbs.nl ; inflation 2001 – 2004); interest rates are monthly data, annual inflation rates are monthly smoothed.

Figure 4.1 illustrates the relationship between nominal and real interest rates and inflation in the Netherlands in the period 1979-2004. It is clear that the nominal interest rate tends to be high when the inflation rate is high, indicating that investors demand a high nominal return for their funds in order to compensate them for the loss in value due to the high inflation rate. This concern about real rather than nominal returns implies that nominal interest rates are in general more volatile than real interest rates. As shown in Figure 4.1, however, the real interest rate also varies considerably over time. Note, in particular, that (i) the real interest rate can be higher than the nominal interest rate, as happened in a period of negative inflation (deflation) in 1987, and (ii) the real interest rate can be negative if inflation is higher than the nominal interest rate, as happened in 2001 and 2003.

Figure 4.2 Germany; interest rates and term structure

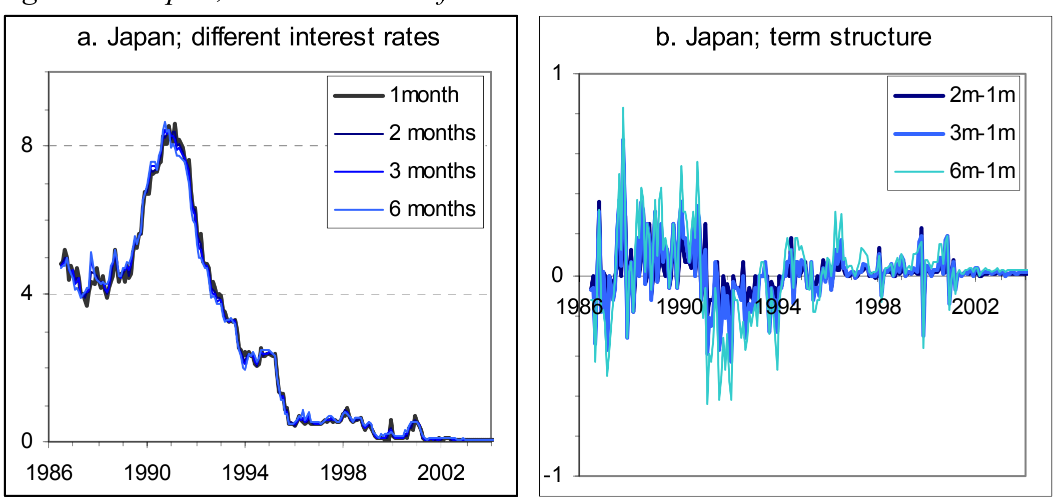


Data source: IFS; shown rates are interbank offered rates

There is, of course, not a single interest rate within a country. There are different interest rates for customers with varying reliability (see also section 4.6) and there are different interest rates for varying time periods, that is with varying terms to maturity. In the bond market we observe, for example, interest rates for 3 months, 6 months, 1 year, etc. Fortunately, as illustrated for Germany in panel *a* of Figure 4.2, the different national interest rates move up and down very closely together. In this respect it is not too far-fetched to refer to *the* national interest rate, as most of the remainder will do.

Nonetheless, interest rates do not move rigidly up and down together, as illustrated more clearly in panel *b* of Figure 4.2 by subtracting the 1-month interest rate at any point in time from the 3-, 6-, 9-, and 12-month interest rates to highlight changes in these differences. The structure of interest rates over time to maturity is known as the *term structure* of interest rates. If the interest rates rise with the term to maturity, the term structure is said to be *rising*, if the interest rates are the same for all terms to maturity, the term structure is said to be *flat*, etc.

Figure 4.3 Japan; term structure of interest rates



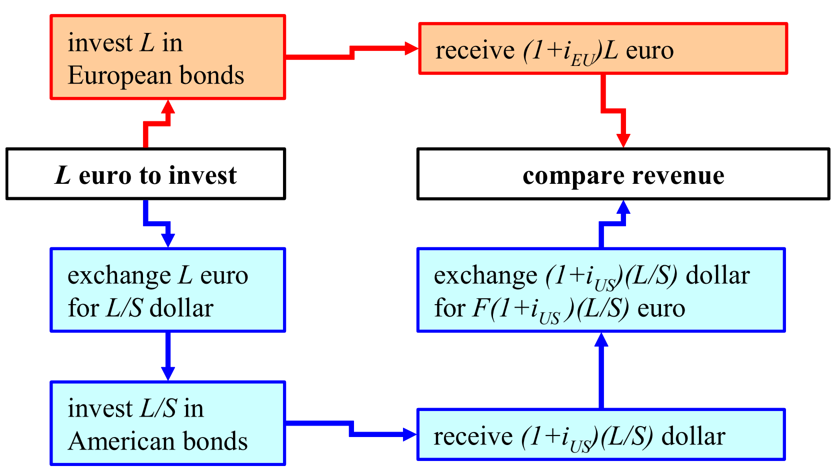
Data source: IFS; shown rates are interbank offered rates

According to the liquidity premium theory, risk-averse investors prefer to lend short term and therefore put a premium on long term bonds, resulting in interest rates rising with the holding period of the bond and thus a *rising* term structure. In panel *b* of Figure 4.2, this would translate into larger positive differences relative to the 1-month interest rate with increasing maturity. This rising term structure was actually observed in Germany in the period 1991 – 2004 most of the time. The figure also illustrates, however, that a falling term structure also occurred frequently, namely in 1992-1994, 1995/96, 1999, 2001, and 2002/3. Other demand and supply factors for individual segments of maturities are therefore strong enough to invert the liquidity premium theory's presumption of a rising term structure. Figure 4.3 shows that similar results hold for Japan in the period 1986 – 2004, where panel *a* illustrates that the various national interest rates move up and down very closely together and panel *b* that the term structure can be either rising or falling. In addition, the figure illustrates a phenomenon specific to Japan in the second half of 1999 and since May of 2001: there is a lower bound of zero on the nominal interest rate.

4.3 Covered interest parity

The discussion in section 4.2 focused on investments by Europeans in bonds in euros. There are, of course, many other (international) investment options open. For clarity, we will consider only one other option, namely buying an American bond rather than a European bond. We will assume that the two assets are *perfect substitutes*, implying in particular that there is no difference in perceived riskiness of one asset relative to the other (see section 4.6). Suppose, for concreteness, that you have a large sum L of euros to invest for one time period and care only about the return in euros. Figure 4.4 diagrammatically shows two possible investment options.

Figure 4.4 Two investment options



- Option I: you can purchase a European bond. If the European interest rate is equal to i_{EU}, you will receive $(1+i_{EU})L$ euros by the end of the period.
- Option II: you can purchase an American bond. Since these are denominated in dollars, you will have to be active on the foreign exchange market. First, by exchanging your L euros on the spot market for L/S US dollars, where S is the spot exchange rate of the US dollar (its price in euros). Second, by investing these L/S dollars in American bonds. If the American interest rate is equal to i_{US}, you will receive $(1+i_{US})(L/S)$ dollars by the end of the period. You are, however, not interested in the return in dollars, but only in the return in euros, so you will have to convert these dollars at the end of the period back to euros. This poses a problem because at the moment you are making your investment decision (option I or option II), you do not yet know what the future spot exchange rate of the dollar is going to be. This is where the forward exchange market provides a solution. Since you know exactly how many dollars you will receive one time period from now if you choose option II (namely $(1+i_{US})(L/S)$ dollars), you will also know exactly how many euros you will receive if you sell these dollars before making your investment decision at the forward exchange rate F on the forward exchange market, namely $(1+i_{US})(F/S)L$ euros.

In short, you exactly know the return to your investment if you choose option I and the return to your investment if you choose option II. Obviously, many other economic agents make similar calculations as you do (possibly trying to benefit from arbitrage opportunities) and all of you will invest in the asset with the highest return. If the two assets are perfect substitutes and both are held in equilibrium, the return to the two assets must therefore be the same to ensure that the market does not prefer one asset over the other, that is we have the following equilibrium condition:

$$(4.2) \qquad \frac{F(1+i_{US})}{S}L = (1+i_{EU})L \quad \Rightarrow \quad \frac{F}{S} = \frac{1+i_{EU}}{1+i_{US}}$$

Stating the blatantly obvious explicitly: the time frame for equation (4.2) must be consistent, so if F is, for example, the three month forward rate, than i_{EU} and i_{US} must be three month interest rates. Recalling the convention introduced in Chapter 3 that lower case letters of symbols in general refer to the natural logarithm of upper case letters, you may have noted that we have right away used a lower case letter i to denote the interest rate. This is not a mistake, but a

Convention exception: lower case letters for interest rates are not natural logarithms.

There is a good reason for this exception, as we will now see. The second equality of condition (4.2) can be written more tersely by taking the natural logarithm and using the approximation $\ln(1+x) \approx x$ (where the symbol $\approx$ should be read as "is approximately equal to") as discussed in Box 4.1, to get (see Technical Note 4.1 and Box 4.2):

(4.2') $f - s \approx i_{EU} - i_{US}$

Equation (4.2') states that the logarithmic difference between the forward rate and the spot rate must be equal to the difference between the domestic and the foreign interest rate. It is known as the *covered interest parity condition*, because you have fully covered your exposure to your return in foreign currency on the forward exchange market. It provides a powerful and crucial relationship between interest rates and (spot and forward) exchange rates in international money and finance analysis. Its counterpart, *un*covered interest parity, will be discussed in section 4.5.

Box 4.1 Linear approximation

Recall from your analysis class that if $g(x)$ is a smooth function, which means that it can be differentiated as many times as necessary, then the value of the function can be approximated by a Taylor series expansion around any point x_0 as follows:

(4.3) $g(x) = g(x_0) + g'(x_0)(x - x_0) + (1/2)g''(x_0)(x - x_0)^2 + ...$

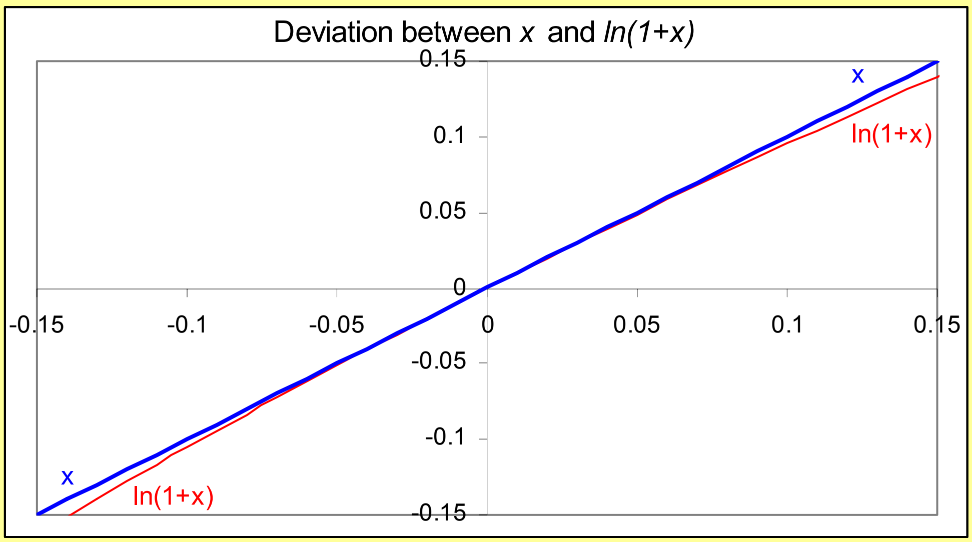
A linear approximation ignores all terms after the first derivative

(4.3') $g(x) \approx g(x_0) + g'(x_0)(x - x_0)$

Suppose we want to have a linear approximation of the function $g(x) \equiv \ln(1+x)$ around the value $x_0 = 0$. According to (4.3') we must then first determine the value of the function g and the value of the derivative g' evaluated at the point $x_0 = 0$. This gives us

$g(0) = \ln(1+0) = 0$ and $g'(0) = 1/(1+0) = 1$. Using that information in (4.3') gives us the approximation $\ln(1+x) \approx x$ discussed in the text. Figure 4.5 shows that this approximation is very accurate for small values of x. Since the covered interest parity condition (4.2') uses it to approximate the natural logarithm of interest rates, which are usually quite small (say smaller than 10 per cent), the approximation is usually quite accurate. Only under extreme conditions, such as under periods of hyperinflation, is it better to focus on the original condition (4.2) or not to use the approximation.

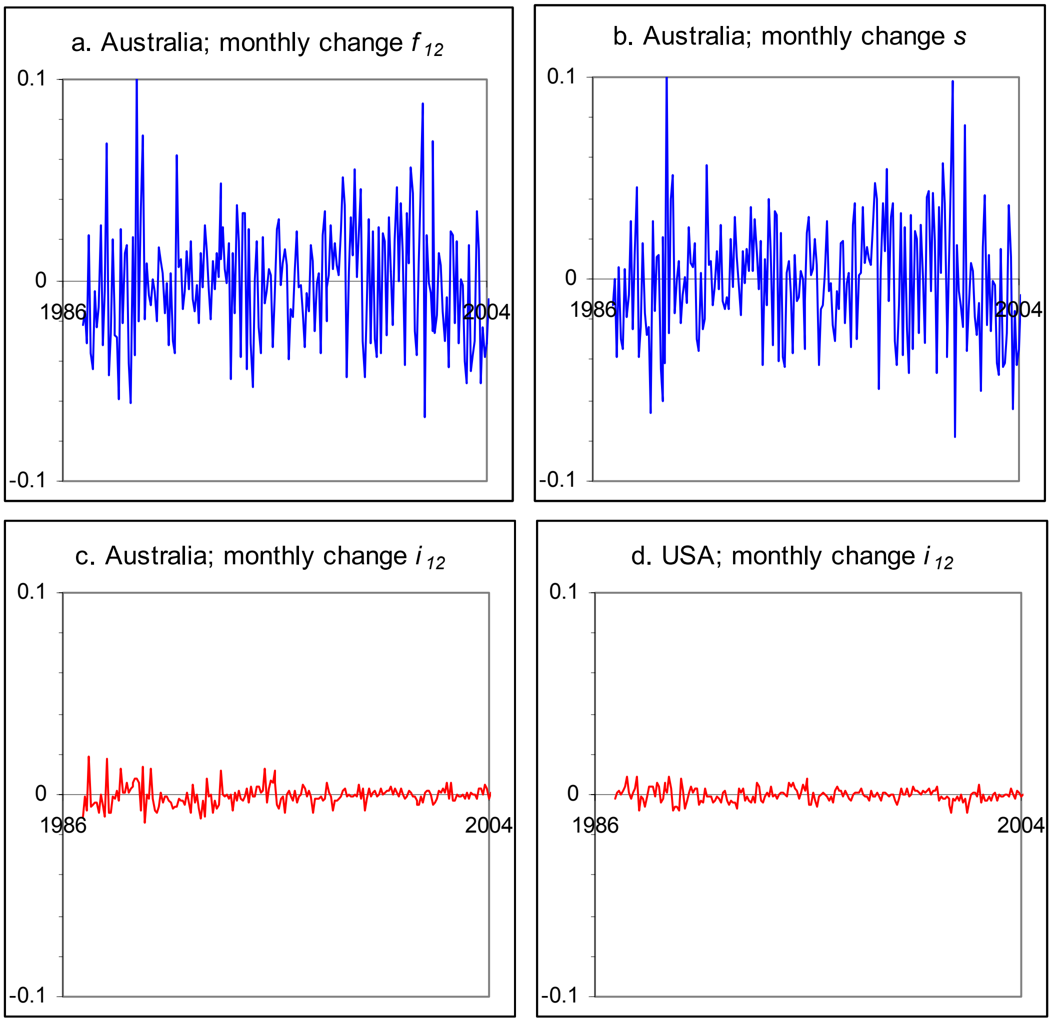
Figure 4.5 Accuracy of linear approximation of ln(1+x)



4.4 The empirics of covered interest parity

In deriving the covered interest parity condition we assumed that the assets involved were perfect substitutes. Moreover, the derivation ignored transaction costs. If either assumption is not met in practice, this may cause a deviation from the covered interest parity condition. Nonetheless, this section will argue that the covered interest parity holds almost perfectly, that is within a very narrow range for very similar types of international assets. To illustrate this, we will continue with our Australia – USA example already discussed in section 20.4. In the analysis below we will measure time periods in months. To indicate this, f_{12} will denote the 12-month forward rate of the US dollar (measured, of course in Australian dollars), i_{12} will denote the 12-month interest rate, etc.

Figure 4.6 Australia and USA; variability in exchange rates and interest rates



Data source: IFS; shown interest rates are interbank offered rates; see the text for details.

We already know that exchange rates are very volatile. Panels *a* and *b* of Figure 4.6 confirm this volatility for forward and spot rate by depicting the change in *f* and *s*, that is $f_{12,t} - f_{12,t-1}$ and $s_t - s_{t-1}$. Box 4.2 explains that this actually gives a (very good) approximation of the relative change of the level variable, so for the spot rate we have $s_t - s_{t-1} \approx (S_t - S_{t-1}) / S_{t-1}$ and similarly for the forward rate. Interest rates are also pretty volatile if we focus on relative changes. However, the covered interest parity condition is $f - s \approx i_{EU} - i_{US}$, that is it relates the log difference in forward and spot rate with the difference in interest rates (and not their relative changes). Using the same vertical scale as for panels *a* and *b*, panels *c* and *d* of Figure 4.6 show that changes in the levels of the interest rate are not of the same order of magnitude as changes in the log of the forward and spot rate. At first sight, this difference in changes may make it hard to see how covered interest parity can hold. However, the parity condition relates *differences* in *f* and *s* with *differences* in interest rates. This implies that the condition may still hold if most of the change in *f* is usually absorbed by a change in *s* (and not by a change in interest rates), or vice versa. As we will see, this is indeed the case.

Box 4.2 Basic properties of (natural) logarithms

Logarithms are used frequently in financial research, mainly because they make the analysis of products, ratios, and powers more simple by transferring these into sums, differences, and products, respectively, through their three basic properties:

- the log of the product ab is the sum of the logs: $\ln(ab) = \ln(a) + \ln(b)$
- the log of the ratio a/b is the difference of the logs: $\ln(a/b) = \ln(a) - \ln(b)$
- the log of the power a^b is the product of b and log a: $\ln(a^b) = b\ln(a)$

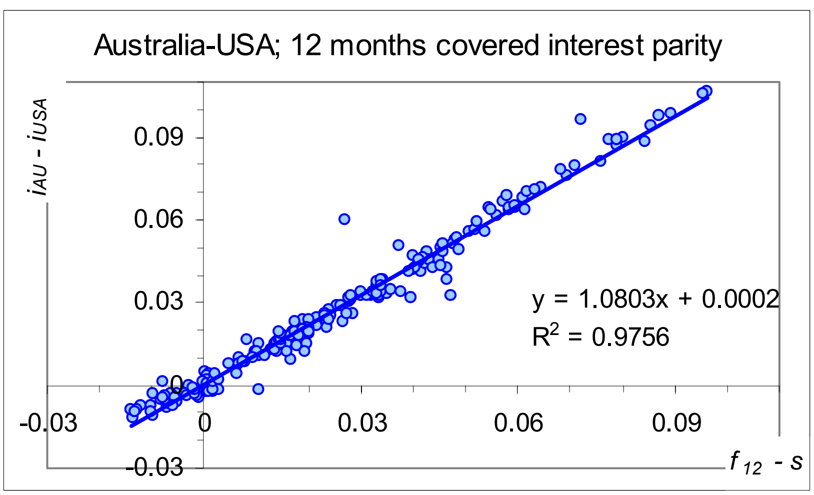
Table 4.1 Approximation accuracy; Australia – US $ spot exchange rates, 2003

	exchange rate US $		relative changes and errors (in per cent)		
			a. exact	*b*. approximation	error
2003	S_t	$s_t \equiv \ln(S_t)$	$100 \cdot (S_t - S_{t-1})/S_{t-1}$	$100 \cdot (s_t - s_{t-1})$	*a-b*
January*	1.78078	0.577051	-0.267	-0.268	0.000
February	1.70794	0.535288	-4.090	-4.176	0.086
March	1.62880	0.487844	-4.634	-4.744	0.111
April	1.65330	0.502773	1.504	1.493	0.011
May	1.58353	0.459657	-4.220	-4.312	0.092
June	1.51964	0.418473	-4.035	-4.118	0.084
July	1.47896	0.391339	-2.677	-2.713	0.036
August	1.53480	0.428400	3.776	3.706	0.070
September	1.55231	0.439744	1.141	1.134	0.006
October	1.45613	0.375782	-6.196	-6.396	0.200
November	1.43379	0.360321	-1.534	-1.546	0.012
December	1.37381	0.317588	-4.183	-4.273	0.090

Calculations based on IFS data; * the January change is relative to the 1 Dec. 2002 exchange rate: 1.78555

Another advantage of using logarithms is that their change represents the *relative* change of the original variable since the derivative of $\ln(X)$ is $1/X$. So, if we use our convention and define $x \equiv \ln(X)$, we get $dx = (1/X)dX$, that is the growth rate of the variable X. It is this property which underlies the fact that the slope of a time variable represents its growth rate when a logarithmic scale is used. If time is continuous, as in the theory chapters to follow, the change in natural logs is actually equal to the growth rate. If time is discrete, as in empirical work, the growth rate can be approximated using the difference in logs. Table 4.1 shows how accurate the approximation is using the monthly 2003 US dollar exchange rates in Australia as an example. This represents actually a tough test because exchange rates are extremely volatile. Nonetheless, the maximum error is only 0.2 per cent, namely in October 2003 when the actual relative change is -6.196 and the logarithmic approximation gives -6.396. Panels *a* and *b* of Figure 4.6 therefore give the monthly relative change of the forward and spot rate.

Figure 4.7 Australia – USA: 12-month covered interest parity



Data source: see Figure 4.5.

Figure 4.7 gives a rough idea that the covered interest parity condition does hold empirically. It is, of course, not a proper econometric test, which would have to make sure that (i) the home and foreign assets are indeed comparable in terms of maturity and default and political risk (hence euro-currency deposits are frequently used, see Levich, 1985), (ii) econometric problems as discussed in Chapter 3 are avoided, and (iii) transaction costs are taken into consideration. In view of the sophisticated computer and communication equipment used today in modern foreign exchange dealing rooms, which makes transaction costs small and covered interest parity indeed riskless, it should come as no surprise that covered interest parity holds almost perfectly. In an analysis of five major currencies against the US dollar, Clinton (1988), for example, finds that the neutral band, which is determined by transaction costs, should be within 0.06 per cent per annum from parity. Before the advanced computing and communication equipment was available the margins were, of course, considerably larger.

4.5 Uncovered interest parity

In section 4.3 we compared two options available to you if you had a large sum L of money available for investment for one period, namely buying European or American bonds. After calculating the return to each option, we concluded that both assets were going to be held in equilibrium only if the return to each asset is the same, which resulted in the derivation of the covered interest parity condition. In that discussion we realized that if you purchased the American bond, you were exposed to foreign exchange risk. To avoid this risk we decided to hedge it on the forward exchange market by selling the dollars to be received next period for a price agreed upon today. In comparing the revenue from the two options, there was therefore no difference in riskiness involved since we assumed explicitly that the default and political risk of the two assets was the same. Hence we were justified in demanding the same return.

There are, under the circumstances described above, of course more options available to you. One of these options (called option III below) is *not* to hedge your risk on the forward exchange market. For clarity of exposition, it is better to now explicitly add a sub index t to denote time. Let's compare your revenue from option I, that is buy the European bond, with the revenue from option III: buy the American bond and do not hedge on the forward exchange market. Nothing has changed for option I, so:

- revenue from buying European bond: $(1+i_{EU,t})L$.

Before you can purchase the American bond you have to convert your euros to dollars at the exchange rate S_t, which will give you L/S_t dollars. In the next period your revenue will therefore be $(1+i_{US,t})(L/S_t)$ dollars. You have decided not to hedge you foreign exchange risk, so in the next period you will have to exchange your currency on the spot exchange market. In this period, when you have to make your investment decision, you obviously do not know next period's spot exchange rate. To make your decision you will therefore have to form some expectation today about the future spot exchange rate. This can be a simple (single number) or complicated (distribution function) expectation. Let's denote the expected value of your forecasting process by S_{t+1}^e, then we conclude:

- *expected* revenue from buying American bond: $\frac{S_{t+1}^e(1+i_{US,t})}{S_t}L$

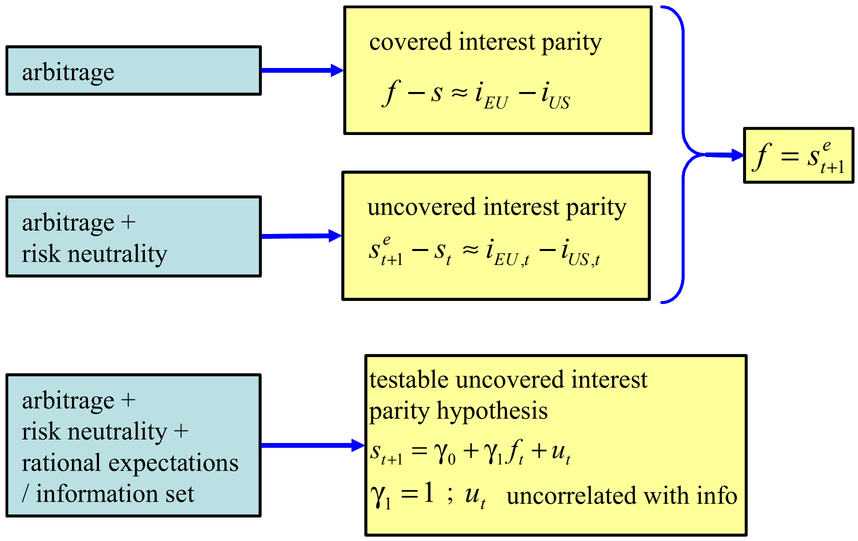
We cannot draw immediate conclusions from comparing these two revenues, because you know the return to investing in the European bond for sure, whereas the return to investing in the American bond is uncertain. Only under the additional assumption of *risk neutral* economic agents, hypothesizing that agents just focus on the expected value of the return and do not care at all about the underlying distribution of risk, should the sure return to the European bond be equal to the expected return of the American bond. Under that assumption, then, and after a similar logarithmic transformation and approximation as discussed in section 4.3, we arrive at the *uncovered interest parity condition*:

(4.4) $s_{t+1}^e - s_t \approx i_{EU,t} - i_{US,t}$

Equation (4.4) says that the difference in home and foreign interest rate must be equal to the expected appreciation of the foreign currency. As such, the equation is pretty useless for empirical testing because it contains the expectation of the future exchange rate and expectations cannot be measured. Alternatively, you can view it as a simple method to define these expectations under the assumption of risk neutrality. In combination with the covered interest parity condition (4.2'), however, it is trivial to see that the forward exchange rate should be equal to the expected value of the future spot exchange rate:

(4.5) $f = s_{t+1}^e$

Figure 4.8 Assumptions, interest parity, and market efficiency



Equation (4.5) still does not give us a testable hypothesis, unless we are willing to go one step further, namely by assuming *rational expectations*. Under rational expectations economic agents make no systematic forecast errors. They will, of course, not be able to exactly predict the future exchange rate, but their prediction should reflect all information available to them at the time they are making the prediction. Any forecasts errors must therefore be uncorrelated (that is not systematic) with the information set available at the time of the prediction. Under the additional assumption of rational expectations, the uncovered interest parity condition can therefore be tested by estimating a regression similar to (see Box 21.1 and Frenkel, 1976):[17]

(4.6) $s_{t+1} = \gamma_0 + \gamma_1 f_t + u_t$,

where u_t is the (forecast) error term. Under the hypothesis of risk neutrality and rational expectations, we expect the parameter γ_1 to be equal to unity and the forecast error to be uncorrelated with the information available at time *t*. Empirical estimates of equations like (4.6) are frequently called tests of *market efficiency*. There are different types of market efficiency, where the joint hypothesis of risk-neutrality and rational expectations is dubbed the *simple efficiency hypothesis* by Sarno and Taylor (2002, p. 10). Figure 4.8 schematically summarizes this discussion.

4.6 Risk premium and transaction costs

When comparing the revenue from purchasing a European bond with the revenue from purchasing an American bond in the previous section, we noted that the European agent was exposed to foreign exchange risk when purchasing the American asset. In general, we can identify three types of exchange risk exposure.

- *Translation exposure*; this accounting exposure arises from assets and liabilities denominated in foreign currency. Suppose, for example, that a German firm has a foreign subsidiary in Thailand, with the assets and liabilities denominated in Thai baht. The translation process expresses financial statements measured in one currency in terms of another currency. Using the current exchange rate to do this, as is for example required in the US, implies that the net value of the foreign subsidiary changes in terms of euros, even if it does not change in terms of baht.
- *Transaction exposure*; this arises from engaging in transactions denominated in foreign currency, such as a Japanese firm selling watches to a French firm with payment on delivery in 3 months time. This example was discussed in section 20.4, where it was pointed out that the firm can hedge transaction exposure on the forward exchange market.
- *Economic exposure*; this focuses on the exposure of changes in a firm's value to changes in the exchange rates. If a firm is active in many countries, with associated receipts and payments in different foreign currencies, and the value of the firm is equal to the present value of all future after-tax cash flows in these countries translated to the base country currency, then it is clear that economic exposure is the most comprehensive measure of exposure to foreign exchange risk (and far from easy to calculate).

In deriving the uncovered interest parity condition (eq. 4.4), we assumed that the economic agents were risk neutral, that is in comparing the revenue from purchasing the European versus the American bond they just focus on the expected value of the return and do not care at all about the underlying distribution of the risk. In practice, however, we expect individuals and organizations to exhibit *risk aversion*: other things equal, they prefer less risk to more risk. This does not mean that risky assets will not be held in

[17] For econometric reasons the actual test is now usually in deviation from s_t, see also below and chapter 21.

equilibrium, just that risk-averse investors will demand a compensation for holding these assets. This is called a *risk premium*. It implies that firms, individuals or countries with bad credit (considered to be a more risky investment) must pay a higher interest rate than those with good credit. The risk premium will rise if: (i) the degree of risk aversion rises and (ii) the perceived riskiness increases. Note in addition that the derivation of the uncovered interest parity condition ignored transaction costs, including capital controls (like a tax on capital in- or outflows) and market transaction costs. Including both a risk premium and acknowledging transaction costs, instead of (4.4) we would expect:

(4.7) $$i_{EU,t} = i_{US,t} + (s_{t+1}^{e} - s_{t}) + risk\ \ premium + transaction\ costs$$

Equation (4.7) indicates that the return from investing at home ($i_{EU,t}$) is equal to the return from investing abroad ($i_{US,t}$) *plus* the expected appreciation of the dollar if investing abroad ($s_{t+1}^{e} - s_{t}$) *plus* a risk premium to compensate for the exposure to foreign exchange risk if investing abroad *plus* any transaction costs involved in foreign investments. In short, there is ample reason to expect the uncovered interest rate parity condition (4.4) not to hold perfectly. We should, however, point out three reasons why it may hold approximately for some markets. First, broad transaction costs, both capital controls and market transaction costs, have declined considerably over time. As indicated by equation (4.7), this narrows the band within which uncovered interest parity should hold. Second, for the major, regularly traded currencies we should expect the risk premium to be within reasonable (but non-zero) limits, which again narrows the band within which uncovered interest parity should hold. Third, and perhaps most importantly, equation (4.7) was derived from a *European* perspective. For an American individual or firm, Europe is the foreign country demanding a risk premium and involving transaction costs. Since actual observations are based on the aggregate behavior of both Europeans and Americans, the deviation from uncovered interest parity caused by equation (4.7) and its American counterpart should at least to some extent cancel in the aggregation process, yet again narrowing the band within which uncovered interest parity should hold. This does not mean that risk premia and transaction costs are not important for explaining aggregate behavior. They certainly are, as will be demonstrated in the next section.

4.7 The empirics of uncovered interest parity

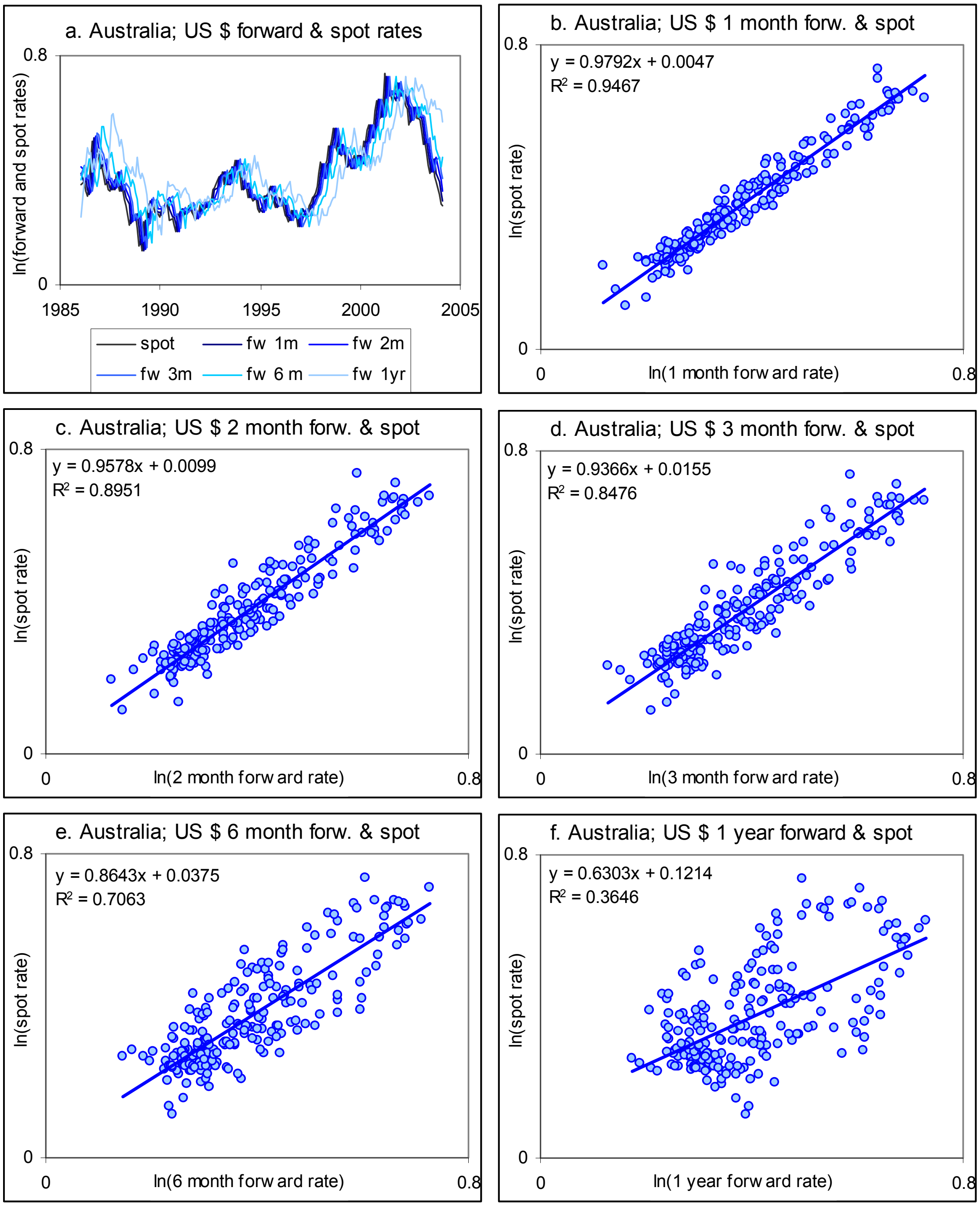
The condition of uncovered interest parity is clearly much more difficult to appropriately test empirically than the condition of covered interest parity, in particular because such tests involve joint hypotheses of risk neutrality and rational expectations, where the latter also implies that proper attention has to be given to analyze which information was available to the economic agents at the time they were forming their expectations. Nonetheless, Figure 4.9 tries to provide some heuristic support for uncovered interest rate parity by continuing our Australia – USA example, based on equation (4.6). Panel *a* of the figure shows the spot exchange rate and the concomittant forward exchange rate that should be viewed as its predictor (appropriately moved forward in time, so by 1 month for f_1, by 2 months for f_2, etc.). Forward and spot rate clearly move up and down together, but there is, equally clearly, considerable deviation between them.

Panels *b-f* of Figure 4.9 show the (in)accuracy of the forward rate as a predictor of the future spot rate in level terms. Clearly, and not surprisingly, the deviation between the forecast and the realization increases if the forecast horizon becomes larger: the observations are much closer to the line for the 1-month forecast than for the 2-month forecast, which are in turn closer than the 3-month forecast, etc. (as reflected in the R^2, the share of the variance that is explained). In addition, for short forecast horizons the prediction seems to be fairly efficient in the sense that the estimated slope coefficient is very close to 1 and the estimated intercept is very close to 0, as should be the case based on equation (4.6).[18] What is more problematic, however, is the fact that the estimated slope coefficient is substantially smaller than 1 and the estimated intercept is substantially larger than 0 if the forecast horizon increases, suggesting that the forward rate is a structurally biased predictor of the future spot rate if the time horizon increases. A possible explanation for this effect may be that investors are not risk neutral and/or there

[18] A statistical t-test as explained in Box 21.1 would show that the slope coefficient is significantly different from 1 if the forecast horizon is longer than 2 months and the intercept is significantly different from 0 if the forecast horizon is longer than 3 months.

are transaction costs, as both assumptions are needed to derive equation (4.6), see the previous section (equation 4.7).

Figure 4.9 Australia – USA: prediction accuracy of forward rates



Data: IFS; Noon NY spot and forward rates; the graphs show spot and corresponding lagged forward rate.

There have been numerous empirical tests of the simple efficient market hypothesis based on the joint hypothesis of risk neutrality and rational expectations. Proper econometric testing in this area is, however, notoriously difficult. Frenkel's (1976) test using levels (eq. 4.6) was criticized for econometric reasons and replaced by tests in deviation from s_t unfavourable for the simple efficiency hypothesis, see for example Fama (1984). However, the non-linear nature of risk premia makes econometric tests based on linearity questionable, see Bekaert and Hodrick (1993). As pointed out by Hansen and Hodrick (1980) an important characteristic of the forward exchange market is its 'overlapping contract' nature: there are contracts with many different times to maturity, which creates serial correlation in the forecast errors (and therefore econometric problems).

Table 4.2 Australia – USA; statistical properties of forward and spot rates

	f_1-s_{-1}	f_2 –s_{-2}	f_3 –s_{-3}	f_6-s_{-6}	f_{12}-s_{-12}
average	0.0031	0.0061	0.0087	0.0152	0.0264
standard error	0.0021	0.0030	0.0036	0.0051	0.0079
minimum	-0.1013	-0.1464	-0.1720	-0.1668	-0.2423
maximum	0.0734	0.1141	0.1295	0.2035	0.3275
correlation coefficients	f_1-s_{-1}	f_2 –s_{-2}	f_3 –s_{-3}	f_6-s_{-6}	f_{12}-s_{-12}
f_1-s_{-1}	1				
f_2 –s_{-2}	0.720	1			
f_3 –s_{-3}	0.579	0.820	1		
f_6-s_{-6}	0.419	0.573	0.719	1	
f_{12}-s_{-12}	0.367	0.493	0.599	0.787	1

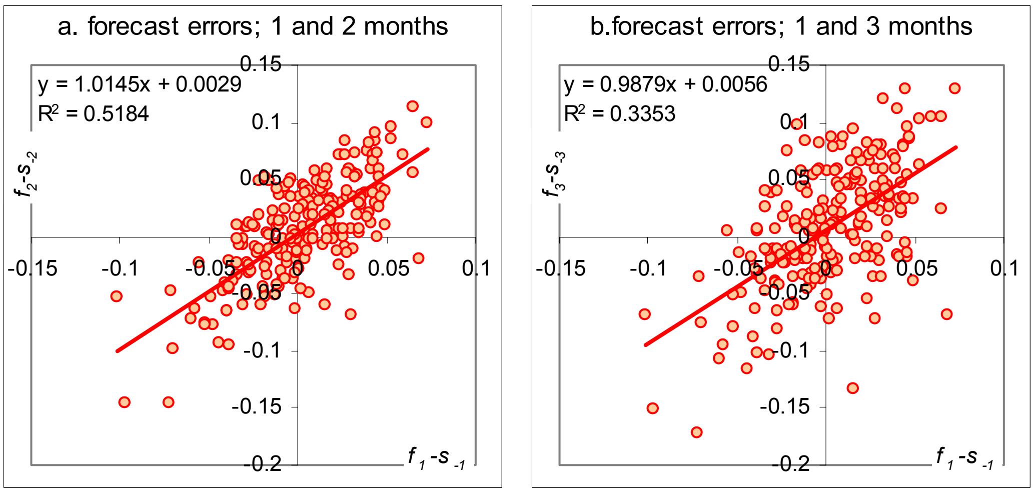
Calculations based on IFS monthly data; 217 observations, February 1986 – February 2004

The correlation problem is illustrated in Table 4.2, which summarizes the statistical properties of the forecast errors, where s_{-1} denotes the one month lagged spot rate, s_{-2} denotes the two month lagged spot rate, etc. It shows that the average error becomes larger and significantly positive if the time horizon increases.[19] The second part of Table 4.2 shows the (very high) correlation coefficients between the forecast errors. This should come as no surprise, since exchange rates are heavily influenced by new information

[19] The falling estimated slope coefficient is thus not fully compensated by the rising intercept in Figure 4.9.

becoming available on changes in economic conditions and policy. As time progresses and more news which influences the exchange rate becomes available, the overlapping forward contracts are affected in a similar way, creating serial correlation.

Figure 4.10 Australia – USA; forecast errors correlations



Another way to look at the correlation problem is by realizing that the errors in shorter terms to maturity contracts provide information on the future errors in the longer terms to maturity contracts. This is illustrated in Figure 4.10 for the extent to which the 1-month forecast error provides information for the 2-month forecast error next month (panel *a*) and for the 3-month forecast error two months from now (panel *b*). Clarida and Taylor (1997) use this structure in a flexible framework to test the information content of the forward exchange rate. They conclude (p. 360): "forward foreign exchange premiums contain significant information regarding subsequent movements in the spot foreign exchange markets. Independently of whether or not foreign exchange markets are characterized by risk aversion or a failure of the rational expectations hypothesis, it appears that the market mechanism is relatively successful in imparting information into the term structure of forward premiums in this respect."

4.8 Conclusions

The Fisher equation provides a direct relationship between interest rates and prices through the decomposition in nominal and real interest rates, where the latter is equal to the nominal interest rate minus the inflation rate. Although nominal interest rates rise with rising inflation rates to compensate for this high inflation, the real interest rate also varies considerably over time and can be both negative and higher than the nominal interest rate. If interest rates increase for longer terms to maturity, the term structure of interest rates is said to be rising. Empirically, it can also be flat or falling.

Hedged international arbitrage between two assets which are deemed perfect substitutes gives rise to the covered interest parity condition: the difference between the home and foreign interest rate is equal to the log difference between forward and spot exchange rate. Empirically, covered interest arbitrage holds almost perfectly. If such international arbitrage between two assets is not hedged on the forward exchange market *and* investors are risk neutral, it is possible to derive the uncovered interest parity condition: the difference between the home and foreign interest rate is equal to the expected appreciation of the foreign currency. In conjunction with covered interest parity this implies that the forward rate is equal to the expected future spot rate.

Tests of uncovered interest parity are based on the additional assumption of rational expectations. These tests, which are frequently rejected empirically, are therefore based on a range of assumptions, including risk neutrality and rational expectations (together forming the simple efficient market hypothesis). Apart from the notoriously difficult econometric problems involved in the testing procedure, this may be caused by transaction costs and risk aversion leading to (time varying) risk premia. Advanced empirical work shows that the term structure of forward premiums contains significant information regarding subsequent movements of spot exchange rates.

Technical Note 4.1 Covered interest parity

Before showing how to get from equation (4.2) to (4.2') it is useful to recall the second basic property of (natural) logarithms (see Box 4.2):

- the log of the ratio a/b is the difference of the logs: $\ln(a/b) = \ln(a) - \ln(b)$

We also use the linear approximation $\ln(1+x) \approx x$ described in Box 4.1. The transformation of the second equality in (4.2) to (4.2') is then as follows:

(4.A1) $$\frac{F}{S} = \frac{1+i_{EU}}{1+i_{US}} \quad \Leftrightarrow \quad \ln\left[\frac{F}{S}\right] = \ln\left[\frac{1+i_{EU}}{1+i_{US}}\right]$$

Since the log of the ratio is the difference of the logs, we know that:

(4.A2) $$\ln\left[\frac{F}{S}\right] = \ln(F) - \ln(S); \quad \textit{and} \quad \ln\left[\frac{1+i_{EU}}{1+i_{US}}\right] = \ln(1+i_{EU}) - \ln(1+i_{US})$$

Using the linear approximation, we know that $\ln(1+i_{EU}) \approx i_{EU}$ and $\ln(1+i_{US}) \approx i_{US}$. Moreover, by our convention we have defined $f \equiv \ln(F)$ and $s \equiv \ln(S)$. Using (4.A2) and this respective information in the second equation of (4.A1), we get:

(4.A3) $$\ln\left[\frac{F}{S}\right] = \ln(F) - \ln(S) \equiv f - s = \ln\left[\frac{1+i_{EU}}{1+i_{US}}\right] = \ln(1+i_{EU}) - \ln(1+i_{US}) \approx i_{EU} - i_{US}$$

This is equation (4.2') in the main text: $f - s \approx i_{EU} - i_{US}$.

Chapter 5 Money organizations and institutions

Objectives / key terms

fixed and flexible exchange rates	policy trilemma
gold standard and gold points	world wars and recession
Bretton Woods	floating rates
parity, devaluation, and revaluation	(n-1) problem
International Monetary Fund (IMF)	World Bank
Bank for International Settlements (BIS)	

We present the so-called policy trilemma to better understand the policy choices made in recent history regarding the international monetary system, including the Gold Standard, Bretton Woods, and the recent Floating Rates era. We also briefly discuss the main international monetary organizations (IMF, BIS, and the World Bank).

5.1 Introduction

Before presenting an overview of the history, structure, and functions of the most important current international monetary organizations, namely the International Monetary Fund, the World Bank, and the Bank for International Settlements, we give an overview of the more recent international monetary institutions. We focus on four main periods in particular, namely the Gold Standard era (1870-1914), the World Wars and Recession era (1914-1945), the Bretton Woods era (1945-1971), and the Floating Rates era (1971-now). To better understand the policy choices made in these periods regarding the structure of the international financial system, it is useful to have a grasp of the so-called policy trilemma, which argues that out of three specific policy objectives only two can be reached simultaneously at the expense of the third objective. This discussion is related to a choice between a fixed exchange rate regime and a flexible exchange rate regime. Our explanation of the policy trilemma in the next section is based on the uncovered interest rate parity condition derived in the previous chapter.

5.2 Exchange rate regimes and the policy trilemma

In theory, we can distinguish between two types of exchange rate regimes, namely *fixed* exchange rates and *flexible* exchange rates. In practice, there is a sliding scale (with associated colourful typology) from one hypothetical extreme to the other, see section 5.6. As the names suggest, the difference between fixed and flexible exchange rates is the extent to which the exchange rate is allowed to change in response to market pressure. Under fixed exchange rates, the central bank of a country has set the exchange rate at a particular level and it will not allow the currency to appreciate or depreciate relative to that level. To maintain the fixed exchange rate, the central bank must be ready to intervene in the foreign exchange market by buying or selling reserves or by increasing or decreasing the interest rate. Under flexible exchange rates, on the other hand, the central bank does not intervene in the foreign exchange market and allows the currency to freely appreciate or depreciate in response to changes in market demand and supply. These issues are discussed further in parts *E* and *F* of this book.

The history of the international economic order on exchange rate regimes and capital market integration is closely connected, see Mundell (1968), Eichengreen (1996), and Obstfeld and Taylor (2003). To better understand this connection, it is useful to distinguish between three possible policy objectives that a nation might try to achieve:[20]

i. Monetary policy independence.
ii. A fixed exchange rate.
iii. International capital mobility.

It turns out that only two of these three policy objectives can be achieved at any one point in time, at the expense of the third objective. Focusing on the EU and the US, this can be illustrated most effectively by recalling the uncovered interest rate parity condition with transaction costs (using a zero risk premium, see equation (22.7)):

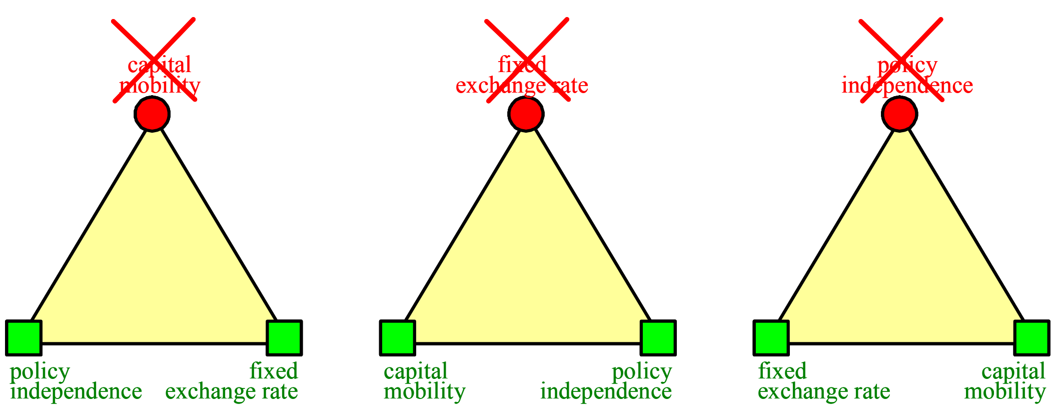
(5.1) $$i_{EU,t} = i_{US,t} + (s_{t+1}^{e} - s_t) + transaction\ costs\ ,$$

[20] See Brakman et al. (forthcoming) for a similar analysis.

where the sub index t denotes time, $i_{EU,t}$ is the EU interest rate, $i_{US,t}$ is the US interest rate, s_t is the (log) US dollar exchange rate (price of one dollar in terms of euros), and s^e_{t+1} is the (log) expected value of next period's US dollar exchange rate.

If there is complete international capital mobility (objective iii holds), the transaction costs are very low, such that equation (5.1) reduces to the uncovered interest parity condition itself: $i_{EU,t} = i_{US,t} + (s^e_{t+1} - s_t)$. This implies that expected changes in the exchange rate are the only reason for an interest rate differential between the EU and the US. With full international capital mobility, policy makers must therefore *choose* between monetary policy independence (reaching objective i, as measured by a possible deviation between EU and US interest rates) and a fixed exchange rate (reaching objective ii). If, for example, they decide to fix the exchange rate ($s^e_{t+1} - s_t = 0$) this automatically implies $i_{EU,t} = i_{US,t}$, making monetary policy independence impossible. Similarly, if they decide to strive for monetary policy independence, this automatically makes a fixed exchange rate impossible ($s^e_{t+1} \neq s_t$). The only way in which objectives (i) and (ii) can be achieved simultaneously is by giving up objective (iii), in which case equation (5.1) with fixed exchange rates reduces to $i_{EU,t} = i_{US,t} + \textit{transaction costs}$. A country can then steer its own interest rate (retain policy autonomy) and have a fixed exchange rate at the cost of immobile capital, which prevents portfolio investors to direct capital flows to or from the EU so as to benefit from the interest rate differential.

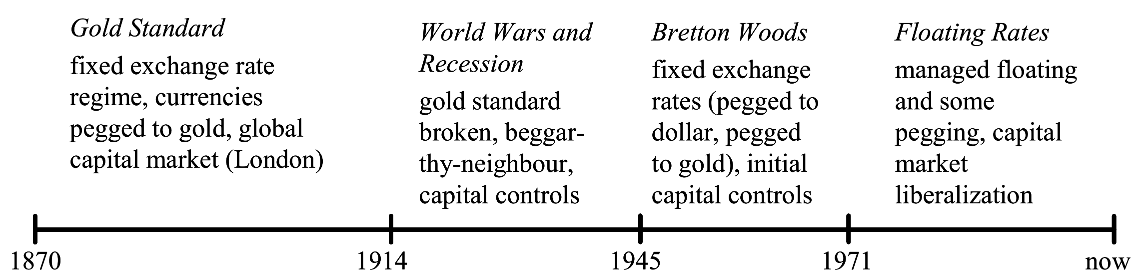
Figure 5.1 The policy trilemma



The incompatibility between objectives (i)-(iii) was pointed out by Nobel laureate Robert Mundell in the early 1960s. It is called the *incompatible trinity*, *incompatible triangle*, or *policy trilemma* and provides us with a categorization scheme that helps us to understand the changes in the international economic order over time. Figure 5.1 illustrates the trilemma. In each triangle of the figure the two squares indicate the objectives pursued by the government, whereas the circle at the top of the triangle indicates the policy objective that cannot be met. The trilemma indicates that there is a price to pay for policy makers when they want to achieve full capital mobility, fixed exchange rates, or policy autonomy. The next four sections discuss how the choices have changed over time by focusing on the most recent main international monetary regimes, see also Eichengreen (1996) and Obstfeld and Taylor (2003).[21] Figure 5.2 gives an overview of these regimes, their duration, and a summary of their main characteristics. They are:

- Gold Standard (±1870 – 1914)
- World Wars and Recession (1914 – 1945)
- Bretton Woods (1945 – 1971)
- Floating Rates (1971 – now)

Figure 5.2 Overview of international monetary regimes



5.3 Gold Standard (±1870 – 1914)

Towards the end of the 19th century, when the United Kingdom was the world's leading economy and London the undisputed global financial centre, an increasing share of the world economy moved to the gold standard. This was a stable and credible fixed

[21] General historical information in the next four sections is based on the Wikipedia encyclopaedia, see http://en.wikipedia.org

exchange rate regime in which countries valued their currency in terms of gold. It started in Britain in 1844 when the Bank Charter Act established that Bank of England Notes, fully backed by gold, were the legal standard. It became an international standard in 1871 when Germany established the Reich mark on a strict gold standard, soon followed by many other European nations, and eventually by Japan (1897), India (1898), and the USA (1900). With countries issuing bank notes directly backed by gold, and by allowing gold to be freely imported and exported across borders according to the gold standard rules, the exchange rates between the currencies became fixed. Suppose, for example, that the Federal Reserve pegs the price of gold at $35 per ounce and the Bank of England at £7, then the exchange rate of the British Pound in terms of US dollars must be 35/7 = 5, otherwise profitable arbitrage opportunities arise. In practice, taking the costs of shipping and insuring gold in transit into consideration, the exchange rates could fluctuate within narrow margins called *gold points*. The gold standard functioned as a disciplining device for countries, which led to a convergence of interest rates and a global capital market centred in London (see also Chapter 2), in exchange for a reduction in policy autonomy.

The gold standard worked quite well at the end of the 19th and the beginning of the 20th century, but there are also several drawbacks to the gold standard. First, although currency backed by gold generally leads to relatively stable prices (see Box 5.1), the rate of inflation is not determined by macroeconomic conditions but by the random discovery of new gold supplies. There have been considerable fluctuations linked to these events, see Cooper (1982). Second, the international payments system requires gold as reserves. As economies are growing, the central banks strive for an increase in the buffer stock of their gold reserves. Simultaneous competition for gold by central banks might bring about unemployment through a reduction in their money supply, see also part *E*. Third, the gold standard gives countries with a large gold supply, such as Russia and South Africa, the ability to influence the world's macroeconomic conditions by selling gold. Fourth, and perhaps most importantly, the gold standard puts undue restrictions on the use of monetary policy as a means for fighting unemployment under special circumstances, such as a worldwide recession.

5.4 World Wars and Recession (1914 – 1945)

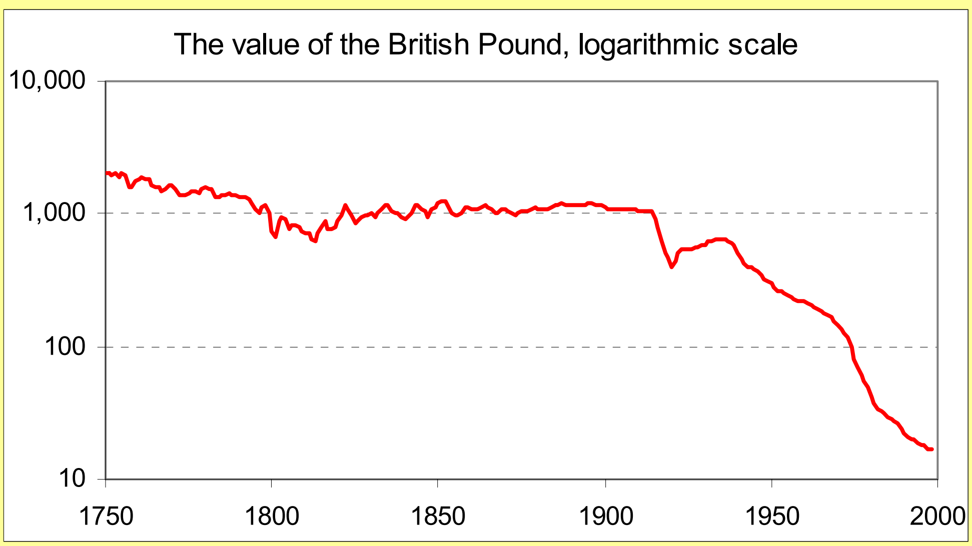
The pillars of the international economic system – the gold standard, multilateral trade, and the interchangeability of currencies – crumbled down one by one during the First World War (1914-1918), the Second World War (1939-1945), and particularly during the Great Depression, which started in October 1929 and lasted throughout the 1930s. To finance its war efforts, Britain ended the convertibility of Bank of England notes in 1914. Nations printed more money than could be redeemed in gold, hoping to win the First World War and redeem the excess out of reparations payments. Losing the war, Germany was indeed required by the Treaty of Versailles to pay large punitive damages, of which in the end it could only effectively transfer a fraction, see Brakman and Van Marrewijk (1998, Ch. ?). To deal with this issue the Bank for International Settlements was established in 1930 under the Young Plan, see section 5.9. Many nations, including the USA and the UK, instituted capital controls to prevent the movement of gold. Britain returned to the gold standard at the pre-war gold price in 1925, which entailed a significant deflation for the economy, much to the dismay of British economist John Maynard Keynes who called the gold standard a "barbarous relic".

The credibility of the gold standard was broken by the First World War, such that countries were no longer willing to give up their policy autonomy for a well functioning international economic system, focusing instead on domestic political goals. Consequently, when the Great Depression hit in 1929 countries engaged in non-cooperative, competitive beggar-thy-neighbour devaluations and instituted capital controls. This greatly exacerbated the crisis, caused the international trade system to collapse, and put millions of people out of a job, with unemployment rates of more than 30 per cent. Both the punitive damages required from Germany in the Treaty of Versailles and the economic consequences of the nationalistic policies imposed during the Great Depression are seen as major contributing factors in causing the outbreak of the Second World War. While the war was raging, politicians and advisors started to work on a plan to avoid this from happening again.

Box 5.1 Price stability under the gold standard

Some historians argue that Britain moved to the gold standard already in 1717 when Sir Isaac Newton was master of the Royal Mint. However, since both a gold and a silver standard were used simultaneously, this is technically a bimetallic standard. During the 1700s and early 1800s a general shortage of silver put pressure on this bimetallic standard, which was officially replaced by a gold standard in 1844. One of the advantages of the gold standard, when adhered to consistently for a long time period, is price stability. This is demonstrated most effectively by Twigger (1999), who uses various sources to calculate a price index for Britain during a 250 year period. Figure 5.3 shows its inverse, the value of British Pound, using a logarithmic scale. Until the start of the First World War, the long-run value of the pound is remarkably stable, although fluctuating considerably from year to year as a result of the quality of harvests, wars, etc. Only after the Second World War, that is in the Bretton Woods and Floating Rates era, does a steady price increase cause a steady decline in the value of the pound.

Figure 5.3 Value of the British Pound, 1750-1998 (index, 1974 = 100)



Data source: Twigger (1999).

5.5 Bretton Woods (1945 – 1971)

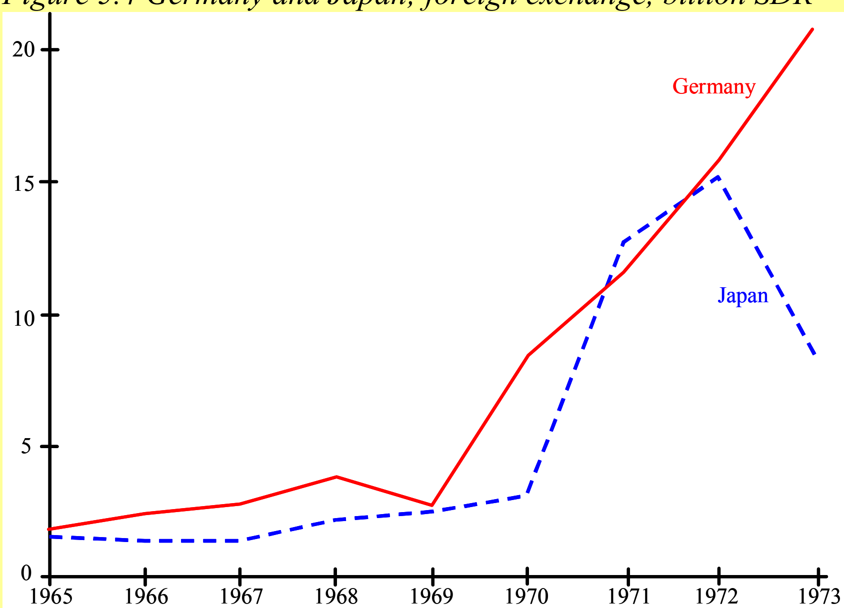
The foundations for a new international economic order were laid at the Mount Washington hotel in Bretton Woods, New Hampshire, when the delegates of 44 allied nations signed the Bretton Woods Agreement in July 1944. The delegates set up a system of rules, institutions, and procedures and established the International Monetary Fund (see section 5.7) and the World Bank (see section 5.8). Planning for the new order had been under way some three years since the American president Franklin Roosevelt and the British Prime Minister Winston Churchill signed the Atlantic Charter in August 1941. There was no question towards the end of the Second World War that the balance of power had shifted towards the United States, political, economic, as well as militarily. This meant that, although there was some compromise towards the British plan designed by John Maynard Keynes, the structure of the Bretton Woods system was based on the plans designed by American Harry Dexter White, who would remain a powerful initial influence at the IMF as the first U.S. Executive Director.

The pillar of the American vision for the post war economic order was free trade. William Clayton, the assistant secretary of state for economic affairs, apparently summed up this point by saying: "we need markets – big markets – around the world in which to buy and sell." Free trade involved lowering tariffs and other trade barriers, a task for the GATT/WTO, and a stable international monetary system to foster the development of trade and capital flows. To do this the gold standard was re-established indirectly through the role of the US dollar as international reserve currency. The US government fixed the price of gold at $35 per ounce and made a commitment to convert dollars to gold at that price (for foreign governments and central banks). In conjunction with the strength of the US economy, this made dollars even better than gold as international reserves, since dollars earned interest and gold did not. Other countries pegged their currency to the US dollar at a *par value* and would buy and sell dollars to keep exchange rates within a *band* of plus or minus 1 per cent of parity. To avoid the beggar-thy-neighbour devaluation problem, member countries could only change their par value with IMF approval, which required a decision by the IMF that the balance of payments was in "fundamental disequilibrium." A decrease in the value of a currency was called a *devaluation*, an increase a *revaluation*.

Box 5.2 The n-1 problem

If there are *n* countries participating in a fixed exchange rate regime with a dominant reserve currency, such as in the Bretton Woods system, there are only *n-1* independent exchange rates. The good news is that only *n-1* countries have to use their monetary policy to fix the exchange rates, leaving one degree of monetary freedom in the system to tackle macroeconomic policy problems. The bad news is that the country with the dominant reserve currency, which in the Bretton Woods system was the United States, will be tempted to use this degree of freedom to tackle its own macroeconomic problems and not those of the other *n-1* countries involved in the system. This is known as the *n-1* problem. Note that the gold standard did not have this asymmetric position of a reserve currency, since all countries were pegging their exchange rate to gold.

Figure 5.4 Germany and Japan; foreign exchange, billion SDR



Data source: De Grauwe (1996, p. 35) ; see Box 5.3 for the definition of SDRs.

We should note that in the Bretton Woods system the other *n-1* countries in principle had the power to discipline the United States by threatening to convert their dollar holdings to gold, to which the US had pegged the dollar. In practice, with the exception of France, very few countries actually used this disciplinary device. During the 1960s, Germany and

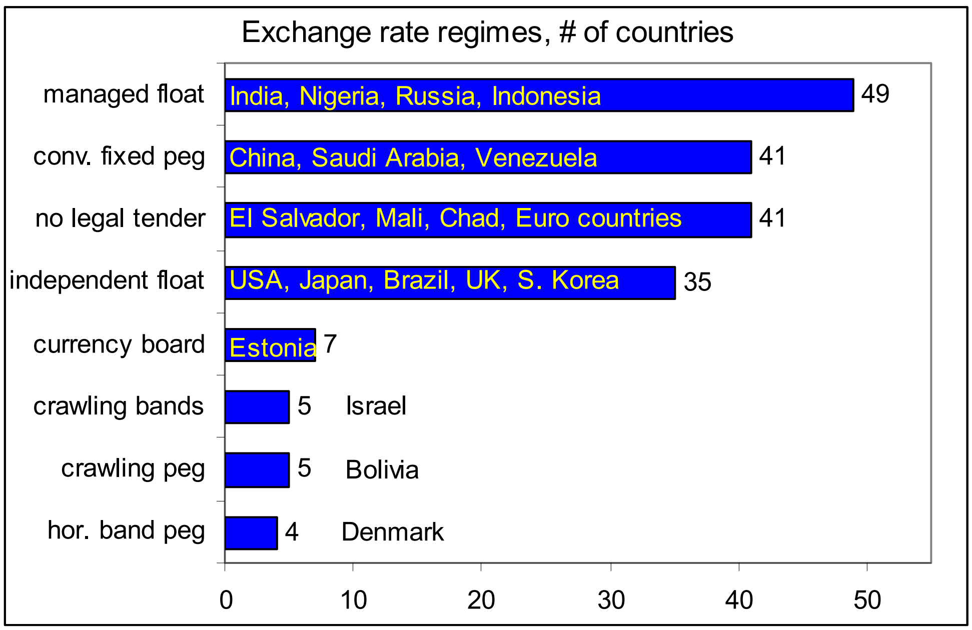
Japan, the key other countries involved in the system, were too dependent on the US (politically and militarily) to afford a confrontation with that country. This implied that although the dollar was legally convertible to gold in practice it was not.

The US used its degree of freedom to try to maintain high growth rates and keep unemployment rates low. This implied expansionary fiscal and monetary policy, leading to high inflation rates and budgetary and current account deficits, particularly in conjunction with the escalating involvement of the US in the Viet Nam war. Although Germany and Japan, keen on keeping inflation rates low, were trying to avoid importing the US inflation rate, they were forced to do so because of their pegged exchange rates in the Bretton Woods system. Speculators realized this dilemma and were massively betting on a revaluation of the German mark and the Japanese yen by purchasing these currencies, which forced the German and Japanese authorities to intervene in the foreign exchange market and accumulate dollar reserves in unprecedented amounts, see Figure 5.4. It was this pressure which eventually forced the collapse of the Bretton Woods system, see section 5.6.

5.6 Floating rates (1971 – now)

Increasing pressure on the Bretton Woods system caused by the n-1 problem (see Box 5.2) during the 1960s and early 1970s caused its collapse. Massive sales of gold by the Federal Reserve and European central banks led to the instalment of a two-tier gold market on March 17, 1968. Private traders could buy and sell gold at a price determined by market forces on the London gold market, while central banks would continue to transact with one another at the (lower) official gold price of $35 per ounce. The latter was only used to a limited amount. Speculation against the dollar forced the German Bundesbank to purchase $1 billion dollar during a single day on 4 May 1971, and another $1 billion dollar during the first hour of the next trading day alone, see Krugman and Obstfeld (2003, p. 560). Germany gave up and allowed the mark to float. It became clear that the dollar had to be devalued. This was, however, very difficult under the Bretton Woods system because it implied that all other currencies, which were pegged to the dollar, had to be revalued with approval from the IMF and all other countries, many of whom were reluctant to do so. Richard Nixon, the American president, forced the issue on 15 August 1971 by formally ending the convertibility of US dollars to gold and imposing a 10 percent tax on all imports into the US until an agreement was reached. Although this *Smithsonian agreement* to devalue the dollar by about 8 per cent came in December of 1971 (at the Smithsonian Institution in Washington DC) it was unable to save the Bretton Woods system. After renewed speculative attacks, there was another 10 per cent devaluation of the dollar on 12 February 1973, followed by a decision of a floating exchange rate of the US dollar relative to the most important international currencies on 19 March 1973.

Figure 5.5 De facto exchange rate arrangements, April 30, 2004



Data source: IMF (2004, pp. 119-120).

Although the present international monetary system is called the Floating Rates era, this does not mean that all currencies are freely determined by market forces. On the contrary, almost all countries at some time or another engage in some type of foreign exchange market intervention, either though their legal framework, direct intervention, or their interest rate policy. As illustrated in Figure 5.5, on the sliding scale from fixed exchange rate regimes to flexible exchange rate regimes, the IMF (2004, p. 118) identifies:

- *No separate legal tender;* The currency of another country circulates as the sole legal tender (formal dollarization), or the member belongs to a monetary or currency union in which the same legal tender is shared by the members of the union.

- *Currency board arrangements;* A monetary regime based on an explicit commitment to exchange domestic currency for a specified foreign currency at a fixed exchange rate. The domestic currency will be issued only against (fully backed) foreign exchange.
- *Conventional fixed-peg arrangements;* The country (formally or de facto) pegs its currency at a fixed rate to another currency or a basket of currencies. The exchange rate may fluctuate within narrow margins and the parity rate may be adjusted.
- *Pegged exchange rates within horizontal bands;* The value of the currency is maintained within certain (wider) margins of fluctuation around a fixed central rate.
- *Crawling pegs;* The currency is adjusted periodically in small amounts at a fixed rate or in response to changes in selective quantitative indicators, such as past inflation differentials vis-à-vis major trading partners, etc.
- *Crawling bands;* The currency is maintained within certain (wider) fluctuation margins and the central rate or margins are adjusted periodically.
- *Managed floating;* The monetary authority attempts to influence the exchange rate without having a specific exchange rate path or target.
- *Independently floating;* The exchange rate is market determined, with any official foreign exchange market intervention aimed at moderating the rate of change and preventing undue fluctuations in the exchange rate, rather than establishing a level for it.

Table 5.1 The policy trilemma and the international economic order

	resolution of trilemma – countries choose to sacrifice:			
Era	policy autonomy	capital mobility	fixed exchange rate	notes
Gold Standard	most	few	few	broad consensus
World Wars and Recession	few	several	most	capital controls especially in Centr. Europe, Lat. America
Bretton Woods	few	most	few	broad consensus
Floating Rates	few	few	many	some consensus; currency boards, dollarization, etc.

Source: Obstfeld and Taylor (2003)

Table 5.1 summarizes the policy choices made by most countries concerning the policy trilemma explained in section 5.2 for each of the four most recent international monetary systems. During the Gold Standard there was broad consensus to give up on policy autonomy in exchange for capital mobility and maintaining fixed exchange rates. This broke down during the World Wars and Recession era, as most countries pursued activist monetary policies to try to solve domestic problems at the cost of either imposing large capital controls or on giving up on fixed exchange rates. In the Bretton Woods era there was again broad consensus to maintain fixed exchange rates, this time by sacrificing capital mobility (which was limited directly after the Second World War and then gradually increased). For the Floating Rates era, the table depicts the more recent policy choices as they have evolved over time, in which many countries have been willing to give up on fixed exchange rates in return for policy autonomy and capital mobility.

5.7 International Monetary Fund (IMF)

As one of the Bretton Woods institutions, the International Monetary Fund (IMF) is located in Washington DC and is the central institution of the international monetary system. It came into existence in 1946 and started operations one year later. With 184 member countries it covers virtually all countries in the world. The IMF's stated objectives are fourfold:

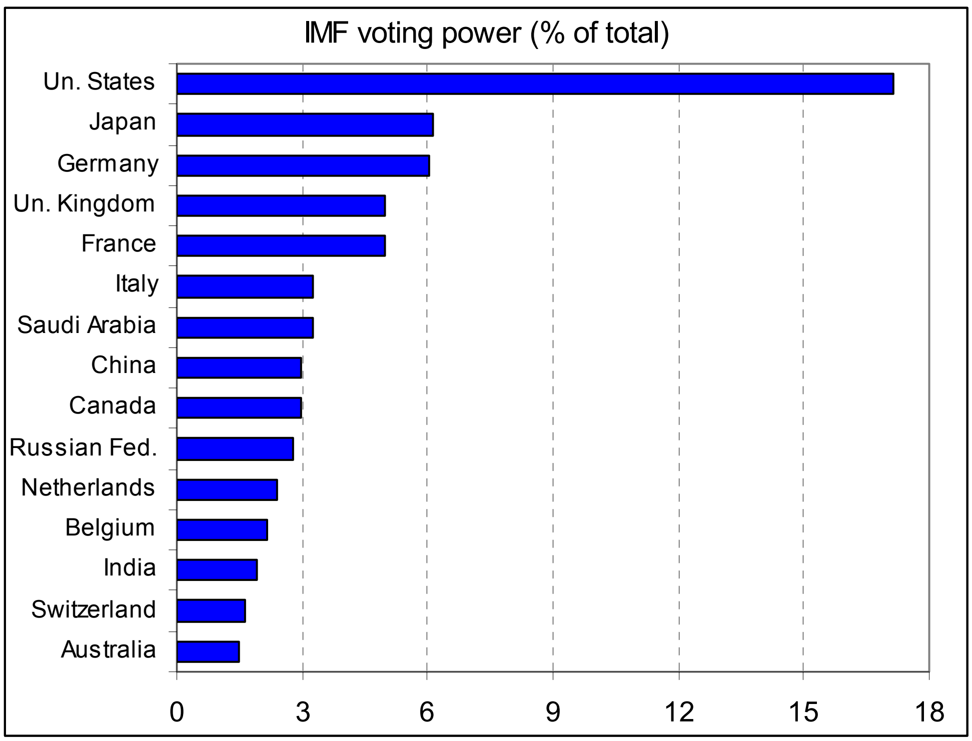
- the balanced expansion of world trade,
- stability of exchange rates,
- avoidance of competitive devaluations, and
- orderly correction of balance of payments problems.

The third of these stated objectives clearly points to the devastating experiences during the Great Depression, see section 5.4.

The IMF employs about 2,800 people from many countries, with two-thirds of its professional staff economists. The highest IMF authority is the *Board of Governors*, which meets once a year with a representative from each of the member countries (usually the Minister of Finance or the president of the central bank). Key policy issues relating to the international monetary system are considered in the *International*

Monetary and Financial Committee (IMFC), which meets twice per year. The day-to-day work is carried out by the *Executive Board*, consisting of 24 Executive Directors; with 8 permanent members (USA, Japan, Germany, France, UK, China, Russia, and Saudi Arabia) and 16 rotating members appointed for two years. Unlike some other international organizations, the IMF has a weighted-voting system, equiproportional to a country's quota in the IMF, which is determined broadly by its economic size and importance in international trade. See Figure 5.6 for the 15 countries with the largest quota as of 2004.

Figure 5.6 Top 15 IMF voting power, April 30, 2004



Data source: IMF (2004, pp. 146-149).

The IMF gets its resources from the quota countries pay when they join the IMF and from periodic increases in these quota, of which countries pay 25 per cent in Special Drawing Rights (SDRs, see Box 5.3) or in major currencies. The quotas determine a country's voting power and the amount of financing it can receive from the IMF. The total quota increased to SDR 212 in 1999. In addition, the IMF has standing arrangements to borrow up to SDR 34 billion if there is a threat to the monetary system, namely under the General

Arrangements to Borrow (GAB, set up in 1962 with 11 participants) and the New Arrangements to Borrow (NAB, set up in 1997 with 25 participants).

Box 5.3 Special Drawing Rights (SDR)

Under the Bretton Woods system, the international monetary system largely depended on gold and US dollars to provide it with the international reserves necessary to support the expansion of world trade. To avoid the dependence of the supply of reserve assets on gold production and US balance of payments deficits needed to provide US dollar reserves, the IMF introduced Special Drawing Rights (SDRs) in 1969, an artificial international reserve asset which the IMF could allocate to members as a percentage of their quotas when the need arose. As the IMF's unit of account, this 'paper gold' has no physical form but is used as a bookkeeping entry for transactions among member countries or with the IMF. The latest allocation, to a total of SDR 21.4 billion, took place in 1981. The value of the SDR is set using a basket of four major currencies, the composition of which is reviewed every five years. In October 2004, one SDR was a composite of euros, yen, pounds, and dollars (approximately 36, 13, 12, and 39 per cent, respectively) and worth about US $ 1.47, see Table 5.2

Table 5.2 Composition and value of one SDR on 8 October 2004

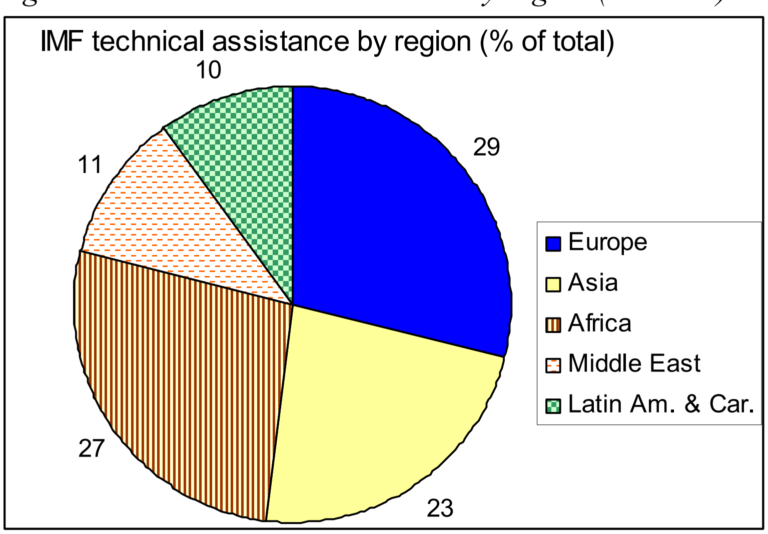
a. composition of one SDR			
currency	weight (units)	value in USD	per cent of total
Euro	0.4260	0.524576	36
Japanese yen	21.0000	0.190097	13
Pound sterling	0.0984	0.175831	12
US dollar	0.5770	0.577000	39
total value of SDR in US dollar		1.467504	100
b. value of one SDR in selected currencies			
Euro	1.19164	Australian Dollar	2.01636
Japanese Yen	162.277	Chinese Yuan	12.1462
Pound Sterling	0.821254	Indian Rupee	67.2558
U.S. Dollar	1.4675	Swiss Franc	1.84964

To perform its tasks, the IMF employs three main functions:

- Surveillance; this is the annual regular consultation with and policy advice to IMF members regarding policies to promote economic growth and stable exchange rates. The IMF views are published in the *World Economic Outlook* and the *Global Financial Stability Report*.
- Technical assistance; this consists of training and assistance for fiscal, monetary, and exchange rate policies, supervision of the banking system, financial regulation, and statistics provision. See Figure 5.7 for the regional distribution of this assistance. After the collapse of the Soviet Union, for example, the IMF helped the Baltic states and Russia set up treasury systems for their central banks.
- Financial assistance; this is provided in particular to countries with balance of payments problems, conditional on implementation of a policy program designed in conjunction with the IMF to correct these problems. For example: (i) during the 1997-98 Asian financial crisis the IMF pledged $ 21 billion to Korea to reform its economy and (ii) in October 2000 the IMF approved a $ 52 million loan (part of a three year $ 193 million loan) to help Kenya cope with the effects of a severe drought.

IMF loans are in principle temporary, usually at low interest rates, and conditional on economic policy implementations. In most cases, IMF approval provides a lending signal to other institutions and investors, enabling the country to attract additional funds.

Figure 5.7 IMF technical assistance by region (FY 2001)



Source: www.imf.org

5.8 World Bank

The World Bank is the sister organization of the IMF. Like the IMF, it is located in Washington DC and has 184 member countries. It came into existence in 1945 and started operations in 1947. Its primary objective is to fight poverty and assist less developed countries in their efforts to improve standards of living and reduce poverty. The World Bank Group consists of the following five institutions:[22]

- International Bank for Reconstruction and Development (IBRD; established 1945, fiscal 2004 lending: $11 billion for 87 new operations in 33 countries); The IBRD aims to reduce poverty in middle-income and creditworthy poorer countries. It is able to borrow at low cost and offer its clients good borrowing terms.
- International Development Association (IDA; established 1960, fiscal 2004 commitments: $9 billion for 158 new operations in 62 countries). IDA provides interest-free credits and grants to the world's 81 poorest countries (with 2.5 billion inhabitants) that otherwise have little or no capacity to borrow on market terms.
- International Finance Corporation (IFC; established 1956, fiscal 2004 commitments: $4.8 billion for 217 projects in 65 countries). Working with business partners and without government guarantees, the IFC promotes economic development through the private sector by providing equity, long-term loans, finance and risk management products, etc.
- Multilateral Investment Guarantee Agency (MIGA; established 1988, fiscal 2004 guarantees issued: $1.1 billion). MIGA helps promote foreign direct investment in developing countries by providing guarantees to investors against non-commercial risks, such as expropriation, currency inconvertibility, war and civil disturbance, etc.
- International Centre for Settlement of Investment Disputes (ICSID; established 1966, fiscal 2004 cases registered: 30). ICSID helps encourage foreign investment by providing international facilities for conciliation and arbitration of investment disputes, thereby helping foster an atmosphere of mutual confidence between states and foreign investors.

The World Bank employs about 10,000 people (of which 3,000 in country offices) from many countries and including economists, educators, environmental scientists, financial

[22] The term "World Bank" refers only to IBRD and IDA.

analysts, anthropologists, engineers, etc. The World Bank is run like a cooperative with the member countries as shareholders, where the weight is determined by the size of a member's economy; in 2004 the USA had 16.41 per cent of the votes, Japan had 7.87 per cent, Germany had 4.49 per cent, etc. The highest authority is the *Board of Governors*, which meets once a year with a representative from each of the member countries (usually the Minister of Finance or the Minister of Development). The day-to-day work is carried out by the *Executive Directors*, with 5 permanent members (USA, Japan, Germany, France, and UK). According to an unwritten rule, the Bank's president is an American, while the managing director of the IMF is a European.

Both the IMF and the World Bank have been under a lot of critique in the past decade regarding the efficacy of their policies. The advice given to the IMF and the World Bank is as diverse as its critics, where some supply-siders argue that the policies are too Keynesian and others that they are too neo-liberal, thinking that free competition and market forces will automatically bring prosperity. Some think that the Bretton Woods institutions undermine the national sovereignty of recipient countries and see these institutions as the political tools of western nations and multinational enterprises.

We should keep in mind, however, that the processes of improving living standards and fighting poverty, the primary tasks of the World Bank, are enormously complicated and time consuming. Adequate evaluation of policy recommendations should be done on a case-by-case basis, taking the country-specific circumstances into consideration. There is no simple panacea for all problems. Like all other institutions and individuals, the World Bank is not infallible and has made plenty of mistakes. At the same time, its assistance and aid has been extremely valuable for alleviating poverty, sometimes under the most difficult of circumstances. In response to its critics, the World Bank has switched from economic growth in the aggregate to poverty reduction and supporting small local enterprises. It is investing in clean water, education, and sustainable development, while adopting a range of safeguard policies to ensure that their projects do not harm certain individuals or groups. It provides detailed information on its analysis and policy recommendations on its website: www.worldbank.org

Similarly, we should keep in mind that by its very nature the IMF usually enters the public arena only once a country is in dire financial straits, sometimes after years of mismanagement or outright theft invisible to the outside world. Local nationals, politicians in particular, are more than willing to point to the IMF as an easy target to blame for the economic hardship associated with trying to overcome these years of mismanagement and theft. Like the World Bank, the IMF is not infallible and can point at both success and failure in its policy recommendations. In response to its critics, the IMF has greatly increased its transparency in recent years. Its reports, Board discussions, consultations, and the staff's analysis is now public information, largely available at the IMF's website: www.imf.org

5.9 Bank for International Settlement (BIS)

Located in Basel, Switzerland, the Bank for International Settlements (BIS) was established in 1930 and is the oldest international financial institution. Initially, the BIS dealt with German reparations issues (hence its name), but its focus quickly shifted to central bank cooperation in pursuit of financial and monetary stability. After the Second World War, the BIS focused on implementing the Bretton Woods system until this system collapsed in 1971. During the oil crises in the 1970s and 1980s the focus was on managing cross-border capital flows and eventually on regulatory supervision of internationally active banks. This led to the Basel Capital Accord in 1988, an agreement among the Group 10 central banks to apply minimum capital standards to their banking sectors (by defining capital and the structure of risk weights). As a result of advances in risk management and technology, a revision of these standards, known as Basel II, is under way (2001-2006), leading to more risk-sensitive minimum capital requirements for banking organizations.

The BIS has a modest staff of less than 600 persons and in 2004 had 55 member central banks, including the OECD countries, but for example also Brazil, India, China, Indonesia, Mexico, and the Philippines. Voting power is proportional to BIS shares issued in the country of each member. The BIS also performs traditional banking functions, such as foreign exchange and gold transactions, and trustee and agency functions. It was, for example, the agent for the European exchange rate arrangements such as the European Monetary System (EMS, 1979-1994) before the introduction of a single currency. Finally, the BIS is instrumental in collecting, compiling, and disseminating economic and financial statistics, such as the triennial central bank survey of foreign exchange and derivatives market activity. This information is available on its website: www.bis.org

5.10 Conclusions

The policy trilemma argues that of the three policy objectives (i) fixed exchange rates, (ii) capital mobility, and (iii) policy autonomy, it is only possible to simultaneously achieve two objectives at the expense of the third objective. We reviewed the main choices made in history for the four most recent international monetary systems: (a) the Gold Standard, (b) World Wars and Recession, (c) Bretton Woods, and (d) the Floating Rates era. During the Gold Standard there was broad consensus to give up on policy autonomy in exchange for capital mobility and maintaining fixed exchange rates. This broke down during the World Wars and Recession era, as most countries pursued activist monetary policies to try to solve domestic problems at the cost of either imposing large capital controls or on giving up on fixed exchange rates. In the Bretton Woods era there was again broad consensus to maintain fixed exchange rates, this time by sacrificing capital mobility (which was limited directly after the Second World War and then gradually increased). In the Floating Rates era, many countries have been willing to give up on fixed exchange rates in return for policy autonomy and capital mobility. The International Monetary Fund is the central institution of the international monetary system, providing surveillance, technical assistance, and financial assistance in case of problems. Special Drawing Rights are artificial international reserves created by the IMF. The World Bank Group consists of five institutions focusing on poverty reduction. The Bank of International Settlements is an organization for central bank cooperation.

References

Balassa, B. (1964), "The purchasing power parity doctrine: a reappraisal," *Journal of Political Economy* 72: 584-596.

Baumol, W.J. (1952), "The transaction demand for cash: an inventory theoretic approach," *Quarterly Journal of Economics*, 66: 545-556.

Bekaert, G., and R.J. Hodrick (1993), "On biases in the measurement of foreign exchange risk premiums," *Journal of International Money and Finance* 12: 115-138.

BIS (2002), *Triennial central bank survey: foreign exchange and derivative market activity in 2001*, Bank for International Settlements, March 2002, Basel.

BIS (2004), *Triennial central bank survey of foreign exchange and derivatives market activity in April 2004: preliminary global results*, Bank for International Settlements.

Bofinger, P. (2001), *Monetary policy: goals, institutions, strategy, and instruments*, Oxford University Press, Oxford, U.K.

Brakman, S., and C. van Marrewijk (1998), *The economics of international transfers*, Cambridge University Press, Cambridge, U.K.

Brakman, S., H. Garretsen, C. van Marrrewijk, and A. van Witteloostuijn (forthcoming), *Nations and firms in the global economy*, Cambridge University Press, Cambridge, U.K.

Cassel, G. (1918), "Abnormal deviations in international exchange rates," *Economic Journal* 28: 413-415.

CBS (2004), *De Nederlandse economie in 2003*, Centraal Bureau voor de Statistiek, Heerlen.

Cheung, Y.-W., and K.S. Lai (1994), "Mean reversion in real exchange rates," *Economics Letters* 46: 251-256.

Clinton, K. (1988), "Transaction costs and covered interest arbitrage: theory and evidence," *Journal of Political Economy* 96: 358-370.

Coenen, G., and J.-L. Vega (1999), "The demand for money in the euro area," ECB working paper No. 6, Frankfurt.

Cooper, R.N. (1982), "The gold standard: historical facts and future prospects," *Brookings Papers on Economic Activity* 1: 1-45.

De Grauwe, P. (1996), *International money*, 2nd edition, Oxford University Press, Oxford, U.K.

Dixit, A.K. (1989), "Hysteresis, import penetration, and exchange rate pass-through," *Quarterly Journal of Economics* 104: 205-228.

Dumas, B. (1992), "Dynamic equilibrium and the real exchange rate in spatially separated world," *Review of Financial Studies* 5: 153-180.

ECB (2004), *Monthly Bulletin*, September, European Central Bank, Frankfurt.

Edison, H.J. (1987), "Purchasing power parity in the long run," *Journal of Money, Credit, and Banking* 19: 376-387.

Eichengreen, B.J. (1996), *Globalizing capital: a history of the international monetary system*, Princeton University Press, Princeton, N.J.

Engle, R.F., and C.W.J. Granger (1987), "Co-integration and error correction: representation, estimation, and testing," *Econometrica* 55: 251-276.

Fama, E.F. (1984), "Forward and spot exchange rates," *Journal of Monetary Economics* 14: 319-338.

Fisher, I. (1911), *The purchasing power of money*, 2nd edition 1926; reprinted by Augustus Kelley, New York, 1963.

Frankel, J.A. (1986), "International capital mobility and crowding out in the US economy: imperfect integration of financial markets or goods markets?," in: R.W. Hafer (ed.), *How open is the US economy*?, Lexington books, Lexington: 33-67.

Frenkel, J.A. (1976), "A monetary approach to the exchange rate: doctrinal aspects and empirical evidence," *Scandinavian Journal of Economics* 78: 200-224.

Frenkel, J.A. (1978), "Purchasing power parity: doctrinal perspective and evidence from the 1920s," *Journal of International Economics* 8: 169-191.

Friedman, M. (1956), "The quantity theory of money: a restatement," in: *Studies in the quantity theory of money*, University of Chicago Press, Chicago.

Glen, J.D. (1992), "Real exchange rates in the short, medium, and long run," *Journal of International Economic*s 33: 147-166.

Granger, C.W.J., and P. Newbold (1974), "Spurious regressions in econometrics," *Journal of Econometrics* 2: 111-120.

Hansen, L.P., and R.J. Hodrick (1980), "Forward exchange rates as optimal predictors of future spot rates: an econometric analysis," *Journal of Political Economy* 88: 829-853.

Harrod, R. (1933), *International economics*, James Nisbet, London.

Hicks, J.R. (1967), *Critical essays in monetary theory*, Clarendon Press, Oxford.

IMF (2004), *Annual Report 2004: making the global economy work for all*, International Monetary Fund, Washington, D.C.

Keynes, J.M. (1936), *The general theory of employment, interest and money*, in: *The collected writings of John Maynard Keynes*, Vol. IV; reprinted by MacMillan, London and Basingstoke, 1971.

Klein, M.A. (1971), "A theory of the banking firm," *Journal of Money, Credit, and Banking*, 3: s 205-218.

Krugman, P.R. (1978), "Purchasing power parity and exchange rates: another look at the evidence," *Journal of International Economics* 8: 397-407.

Krugman, P.R., and M. Obstfeld (2003), *International Economics: theory and policy*, 6th edition, Addison Wesley, Boston, etc.

Leahy, M.P. (1998), "New summary measures of the foreign exchange value of the dollar," *Federal Reserve Bulletin*, October 1998: 811-818.

Levich, R.M. (1985), "Empirical studies of exchange rates: price behavior, rate determination, and market efficiency," in R.W. Jones and P.B. Kenen (eds.) *Handbook of International Economics*, vol. II, North-Holland, Amsterdam: 979-1040.

Marrewijk, C. van (2002), *International Trade and the World Economy*, Oxford University Press, Oxford, U.K.

Melvin, M. (2000), *International money and finance*, Addison, Wesley, and Longman, 6th edition, Reading, etc.

Mill, J.S. (1848), *Principles of political economy*, 2 vols., London: John W. Parker.

Morales, J.A. (1988), "Inflation stabilization in Bolivia," in: Michael Bruno et al. (eds.): *Inflation stabilization: the experience of Israel, Argentina, Brazil, Bolivia, and Mexico*, MIT Press, Cambridge.

Mundell, R.A. (1968), *International economics*, MacMillan, New York.

Obstfeld, M., and A.M. Taylor (2003), "Globalization and capital markets," in: M.D. Bordo, A.M. Taylor, and J.G. Williamson (eds.), *Globalization in historical perspective*, NBER.

Officer, L.H. (1982), *Purchasing power parity and exchange rates: theory, evidence and relevance*, JAI Press, Greenwich, Conn.

Tobin, J. (1956), "The interest elasticity of transactions demand for cash," *Review of Economics and Statistics*, 38: 241-247.

Tobin, J. (1958), "Liquidity preference as behavior towards risk," *Review of Economic Studies*, 25: 65-86.

Twigger, R. (1999), "Inflation: the value of the pound 1750-1998," Research Paper 99/20, House of Commons Library, U.K.